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Pupillary Responsivity to Ambiguous and Non-ambiguous Stimuli as a Discriminate of Introversion - Extraversion

by

Frederick I. Meek
B.A., McMaster University, 1974

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ABSTRACT

The purpose of the present study was to investigate the effect of ambiguous and non-ambiguous content of a personality inventory item on the pupillary responsivity of subjects classified as extraverts and introverts, and to determine if pupillary variables could discriminate between extraverts and introverts.

Two hundred male students were tested with the Maudsley Personality to obtain 32 subjects: 16 of which were classified as extraverts and 16 as introverts. Each subject was presented with personality items which were categorized as ambiguous and non-ambiguous by using Goldberg's ambiguity index -- Ambdex. During the presentation of each experimental stimulus item, the pupil of the eye was photographed at a rate of 20 frames per 12 seconds.

Pupil size was not related to ambiguity. In addition, discriminant function analysis with the physiological variables was not significant.

PREFACE

The impetus for this research came principally from previous published and unpublished articles concerning the relationship of pupillary activity to motor response involvement and problem solving and discussions with Dr. R. Daly.

The author wishes to express his appreciation and gratitude to Dr. Raymond Daly under whose patient direction this research was completed.

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CHAPTER 1

INTRODUCTION

The eye is one of the chief information gathering agents of the human organism. Being an important and intricate mechanism, numerous research has been done on each of its components. The "pupil of the eye" has thus been subject to a considerable amount of investigation. Much of the early investigation was directed towards the pupillary reflex -- "the automatic constriction of the pupil of the eye in response to excessive light" (Halliburton, 1967). Some researchers, such as, Darwin (1873), who stated that pupillary dilation in response to fear indicates "that the brain is directly affected by the powerful emotion of fear and reacts on the pupil", instigated studies to show that the pupils were an objective index to sensory, emotional and mental activity. Lowenstein, however, was the chief pioneer in the study of the pupil in a variety of clinical conditions. He contended that sensory stimuli, aroused emotions, and spontaneous thoughts heightened attention. "Mental effort" in problem solving, and reactions to pleasant and unpleasant stimuli resulted in a pupillary response. He stated the dilation of the pupil occurs "with every increase of attention by intellectual processes of every kind, with the beginning of the volitional impulses, or during the course of emotions" (Lowenstein, 1920). Since 1920, many studies have been done to determine the ramifications of Lowenstein's contentions.

The hypotheses for this study are derived and dependent upon at least three main areas of research: These areas are pupillometry, personality theory, namely, the extraversion-introversion theory proposed by Eysenck and psychometric theory as exemplified by the work of Goldberg (1963). In this introduction and discussion, these three areas will initially be treated independently and then in the purpose and design of the present study an attempt will be made to amalgamate the ideas into a cohesive theoretical framework.

A. Theoretical Background of Pupillometrics

There is no definitive theory in the area of pupillometry -- merely speculations. The main opinion is that the autonomic nervous system encompassing the parasympathetic and sympathetic branches controls the activity of the pupil. This system acts upon the two muscles - the sphincter pupilla and the dilator pupilla of the iris to alter the size of the pupil. The parasympathetic fibers from the occilomotor nerve activate the sphincter pupilla and is responsible for pupillary constriction. The sympathetic nerves from the superior cervical ganglion supply the dilator pupilla but its role in dilation in response to light changes is equivocal. The sympathetic fibers are clearly involved in changes in pupil dilation brought about by altered states of consciousness by giving rise to cortico - thalamic - hypothalamic impulses. These impulses elicit sympathetic activity which

is transmitted to the dilator pupilla and inhibit the activity of the oculomotor nucleus, producing relaxation of the sphincter pupilla. Thus the eye dilates. Thus the parasympathetic system is the one that is dominant in pupillary activity to light change and the sumpathetic system is dominant in pupillary activity as a result of sensory and emotional stimuli (Morgan, 1965, pp. 33-35).

Thus the pupillary response is considered to be another measure of autonomic activity along with the electric conductivity of the skin, heart rate, blood pressure and respiratory rate.

B. Review of Pupillometric Research

Although not cited in the literature until many years later, research was done as early as 1900 on the effect of mentally solving arithmetic problems in dilating the pupil by Heinrich (1896) and Rubinovitch (1900, 1901). Hess and Polt (1964) using simple multiplication problems found that there was an increase in the size of the pupil as the problem difficulty and amount of mental activity required increased. Also, the pupils of each subject "gradually increased in diameter, reached a maximum dimension immediately before an answer was given and then reverted to the previous control size." Daly (1966), in an unpublished doctoral thesis, also noted that dilation is significantly greater during problem solving, as compared with a control period. He defined two basic steps during problem solving: 1) the question-answer period: This refers to those times that the subjects asked questions and times when they were given answers to their questions: 2) the final answer period: this refers to the point at which the subject gave his final answer. Of these, the final answer period elicited the greatest amount of pupillary dilation. Pupillary responsivity did not differentiate efficient problem solvers from inefficient ones. Though definite trends did appear, namely, efficient problem solvers tended to have larger pupillary responses than did inefficient problem solvers.

Kahneman and Beatty in a series of studies investigated

the question of task difficulty and pupillary response in relation to what they called the loading--unloading function. In short-term memory tasks, it was noted that pupil diameter is "linearly related to the amount of material stored for immediate recall." During the loading phase, the subject's pupil dilates with every digit he hears; during the unloading phase, his pupil constricts with every digit he reports.

Other findings of their study were that pupil diameter is directly related to the length of the string of digits, that words (which are more difficult than digits) produce larger dilations than the same number of digits (Kahneman & Beatty submitted). For long term memory, similar results were obtained except that the peak diameter was consistently higher than in the short term condition (Beatty and Kahneman, 1966). Kahneman, Onuska and Wolman (1968) investigating the effect of grouping the digits on pupillary responsivity show a steady dilation in the monotonic condition and a series of dilation-constriction waves during the grouped presentation. This absence of pupillary loading function with the grouped presentation was also noted when the subjects heard a series of eight common nouns under free-recall instructions (Kahneman and Peavler, 1968). The explanation offered is that there is a cumulative effect resulting from an inability to rehearse the items heard until all have been presented when the presentation is ungrouped. When grouped, this rehearsal occurs between the presentations of groups producing dilation while

rehearsing and constriction when awaiting for the next presentation.

Two other types of cognitive activity have been investigated: imagining a word or stimulus and making a decision of true or false to an item. When subjects attempted to generate "mental images", the pupil size increases during the task and the amount of dilation is related to the difficulty of the task. Paivio and Simpson (1966) found that pupil size increased during an imagery task and dilation was greater to abstract than to concrete words. Thus, the hypothesis that imagining is more difficult in the case of abstract stimuli was confirmed. Simpson et al. (1968), noting that Simpson and Paivio (1968), and Paivio and Simpson (1968) reported that the response used to indicate task fulfillment contributes to the dilation effect and that the latency of the pupillary response is related to difficulty of the task, investigated the latency and magnitude of the pupillary response during an imagery task. The results indicate that the pupil size was significantly larger than in the control period for each of the three word types (high, medium and low imagery). Confirmation of the previous experiment on the latency of pupillary dilation was obtained. It was also noted that for an imagery task, at least, the time to maximize pupil size is a more sensitive index of task difficulty than is pupil size itself.

Sweeney (1968) investigated the pupillary response to

ambiguous and non-ambiguous items selcted from the MMPI using Goldberg's Amdex. Ambiguous items which were considered to be more difficult produced more dilation than non-ambiguous. To ensure that the subjects could discriminate between the ambiguous and non-ambiguous items, their mean rating was compared with the Amdex values. The correspondence indicated the ability to discriminate and that the task difficulty was related to the ambiguity. The relationship between pupillary response and ambiguity again confirms the hypothesis that task difficulty affects pupil size. Simpson's (1968) contention that latency of the dilation is a more sensitive measure in relation to task difficulty may be specific to imagery tasks. Sweeney (1968) also confirmed this. Further investigation of this measure is necessary with respect to other tasks such as problem solving and true-false answer items.

Nunnally, Knott, Duchnowski and Parker (1967) investigated the question of the pupillary response as a general measure of activation. There was up to this point a great deal of anecdotal and other evidence to support this hypothesis. They tested the sensitivity of pupillary response to five types of stimulation: 1) muscle tension induced by lifting of weights, 2) fear induced by threat of gunshot, 3) intense stimulation induced by loud pure tones, 4) heightened attention from viewing novel pictures, 5) pleasantness and unpleasantness in reaction to pictures that differed in

terms of their affect-inducing characteristics. There were highly regular relationships between degree of muscle strain and pupil size and between the temporal ordering of events during the threat of a gunshot and pupil size. Novelty, pleasantness-un-pleasantness and intense stimulation had significant effects on pupil size.

The importance of the type of stimulation has been investigated by a number of researchers. Hess (1965) postulated that initial pupil dilation indicates interesting or pleasant visual stimuli and initial pupil constriction indicates aversive, distasteful and un-appealing visual stimuli. The occurrence of constriction after a number of presentations indicates a certain amount of adaption and decrease in novelty. Hess' results were replicated by Bergum and Lehr (1966a) but were not replicated by Scott, Wood and Morgan (1967). Scott, Wood and Morgan claim that Hess' results, (Hess & Polt, 1960; Hess, 1965) indicating that homosexual and heterosexual males and females can be discriminated when pictorial stimuli of nude males and females are used,

> are surprising because most autonomic variables display an amount of spontaneous variability which would make the assessment of interest patterns impossible for groups as small as those used by Hess (Scott, Wood & Morgan, 1967, p. 433).

In the subsequent experiment, the authors did not confirm Hess' findings that the sexes respond differently to pictures

of the same and opposite sex. There was no evidence that non-preferred stimuli elicit pupillary constriction. Woodmansee (1967) also attempted to test the validity of the pupil as a "bidirectional physiological index" of positive and negative affect and could not replicate Hess' results using pictorial stimuli. Nunnally et al. (1967) also had similar results. Pupil size for positive pictures was significantly larger than for neutral or negative pictures but the differences between the latter two were not significant. An attempt to produce his "negative responses", that is constriction, when unpleasant sound or taste-stimuli were used instead of visual stimuli was noted by Hess "with surprise". Lowenfeld (1965) stated that all sensory, emotional or intellectual stimuli (with the exception of sight) dilate the pupil and none of them constrict it. She also contends that "the suddenness and intensity of the stimulus and the state of consciousness at the moment of stimulation determine the extensiveneness of the pupillary response" and that "the content of an emotion or an idea does not affect the direction of the pupillary response". The content , however, is considered to be important with respect to the amount of dilation. Miller (1967) reported that stimulus meaningfulness was an important element in pupillary response but was not statistically significant. Overall pupil sizes were significantly smaller to items not solved correctly than for items solved correctly. The results were

successful in differentiating normals from retardates. It would appear reasonable to say that pupillary response is related to its novelty and its meaningfulness. That there is a relationship between pupil size and the affect of the stimulus is questionable due to the discrepant results obtained by researchers (Peavler and McLaughlin, 1967; Scott, Weels, Wood and Morgan, 1967: Gurnan, 1967; Paivio & Simpson, 1966.) One possible explanation is that the stimuli used in the cases not confirming Hess' statement were not novel or "provocative" enough since several studies have related pupillary dilation to tasks associated with producing or requiring arousal or attention (Beatty & Kahneman, 1966; Kahneman & Beatty, 1966, 1967; Nunnally, Knott, Duchnowski and Parker, 1967; Paivio & Simpson, 1966; Libby, Lacey, Lacey, 1968).

In line with the arousal, activation, hypothesis are a series of studies attempting to determine the effect of the response mode on pupil size. In a Paivio and Simpson (1966) study, subjects indicated fulfillment of the task by pressing a telegraph key. The maximum pupil size coincided with the latency of the key press, suggesting that the key press contributed to the dilation. This study was replicated (Simpson & Paivio, 1966) with no key press involved, the amount of dilation during the imagery task was significantly reduced in the experiment without the key press. This issue is of general importance since most studies

studying the use of pupil size as an index of mental activity have used an overt indicator of task fulfillment. Simpson and Paivio (1968) investigated the relationship between pupil size and mode of response. They reported that greater dilation occurred during the imagery task than during a control period only in those conditions in which an overt response indicated task fulfillment. Sweeney (1968) using ambiguous and non-ambiguous MMPI items and six response modes -- 1) Verbal-"True" or "False"; 2) Verbal -"Now"; 3) Key Press-"True" or "False"; 4) Key Press-"Now"; 5) No Overt Response; 6) No Response--found that the verbal response mode did not differ significantly from the key press mode and that these overt modes differed significantly from the covert and no response modes. Thus supporting the hypothesis that an overt response contributes to the dilation of the pupil, Anderson (1968) using high, medium and low social desirability items from the MMPI and the same response modes confirmed Sweeney's results.

As was indicated earlier, the pupillary reflex has been one of the prime targets for study. Rubin (1960) has proposed that the speed of pupillary constriction may be taken as an "indicator of the amount of the cholinergic mediator present" (Holmes, 1967, p. 98) and that the

> "magnitude of constriction is an increasing montonic function of the amount of the cholenergic mediator liberated (Rubin 1960, p. 567).

The amount of cholinergic mediator present is considered to have an important function as far as neural transmission at the synapses is concerned (Eccles, 1957) and subsequently affects the amount of learning. Holmes (1967) attempted to demonstrate that pupillary response was a predictor of learning and in the area of personality. The results

> "clearly related the speed of pupillary constriction to awareness of an environmental contingency, susceptibility to verbal conditioning and to personality in terms of the introversion-extraversion dimension (Holmes 1967, p. 101).

This he hypothesized was due to the fact that the differences in neural conductivity and the resultant differences in reactions and conditioning would play a major role in their personality characteristics especially with regard to the introversion-extraversion dimension.

In summary, the research up to the present day has studied pupillary responsivity in relation to many variables. The basic conclusions that can be made are that the novelty of the stimulus, its interest value, the amount of arousal produced the suddenness of its presentation and the degree of task difficulty are significantly related to the degree of dilation of the pupil. That constriction is produced by stimuli possessing negative affect has not been confirmed. Constriction is produced only by a light stimulus. According to some researchers (Rubin, 1960; Holmes, 1967), the speed of constriction to a light can be

used as a predictor of learning and of personality.

C. Eysenck's Theory of Extraversion - Introversion

Pavlov, Hull and now Eysenck, in addition to other theorists, use two physiologically based processes to describe the mechanics of behavior -- excitation and inhibition. Hull has clarified the meaning of these to a greater extent than the other theorists. "Inhibition" cannot be defined specifically -- the best that can be done is to demonstrate what kind of phenomenon are responsible for the postulation of the concept.

> Inhibition refers to a process within the CNS which interferes with the on-going perceptual, cognitive and motor activities of the organism (Eysenck, 1963, p.2).

There are two types of inhibition: 1) temporal inhibition which is the accumulation of a performance decrement as the result of the performance itself; 2) spatial inhibition which is the production of a performance decrement through some forms of action occurring simultaneously. Eysenck postulates that individuals may have low or high cortical conductivity prior to any stimulation. He thus postulates a characteristic level of cortical conductivity which is a result of differences in stimulus-produced inhibition.

Excitation (arousal?) can be seen as a

> process within the CNS which facilitates the on-going perceptual, cognitive and motor activities of the organism (Eysenck, 1963 p.5).

The notion of habit formation, or sHr as it is referred to by Hullians, and sensory threshilds are a function of the level of excitation of the CNS. Because of the evidence pointing to a relationship between the sensory thresholds and personality, Eysenck postulates a close relationship between the personality dimension of extraversion-introversion and excitation-inhibition. The person with high degrees of extraversion has inhibitory processes that occur quickly, strongly and persistently while excitatory processes occur slowly, weakly and non-persistently. High degrees of introversion are found in people in whom the reverse is true. The typical extravert is sociable, likes parties, likes to have people to talk to, is concerned with his inner-life, impulsive, likes change and has a narrow range of interests. The introvert is introspective, quiet, reserved distant, looks and plans before acting, high value on ethical standards and has many interests.

According to Eysenck, the relationship between the extraversion-introversion dimension and cortical activity is such that the cortex of an introvert is easily excited thus facilitating learning or conditioning and inhibiting the subcortical centers -- the thalamus and hypothalamus. Thus he very rarely expresses anxiety or rage and is very quickly lastingly and strongly conditioned. The extravert, on the other hand, is slowly conditioned due to the inhibition of the cortex which interferes with perceptual, cognitive

and motor activities. If extraverts are given a stimulate drug to excite the cortex faster learning is noted because inhibitory potentials are decreased and excitatory ones increased.

Eysenck has postulated a number of differences between extraverts and introverts.

1) Extraverts show greater pain tolerance than introverts.

2) Extraverts show less stimulus deprivation tolerance than introverts.

3) Extraverts exhibit stimulus hinger and introverts stimulus avoidance.

4) Extraverts show shorter perceptual after-effects.

5) Extraversion-introversion are independent of a second dimension called neuroticism.

6) There is a difference with respect to aesthetics. The extraverts are hypothesized to prefer the highly coloured pictures while introverts the less highly coloured ones.

Eysenck claims that there is numerous empirical evidence to validate these hypotheses -- evidence obtained by researchers other than Eysenck's compatriots. The theory has appeared to have gained a good deal of recognition with respect to predicting the effects of various drugs. Eysenck has a great number of publications which deal with the various areas in which the relationship of excitation-inhibition and extraversion-introversion are well delineated.

Eysenck's theory of personality is, according to Bischop, (1964) almost as controversial as Freud's. He explains that this is in part due to his attempt to formulate a theory based on Jung's introverted and extraverted types and Kretschmer's body types. Eysenck criticizes and has been criticized by many researchers concerning methodology used in experimentation and the deductions that follow from these. However, it is considered that his test -- Maudsley Personality Inventory -- does have acceptable validity and reliability.

D. Ambiguity

Defining the area:

In the study of psychometrics and in the actual formulation of test instrument, one of the most important considerations is reliability. That is, if the test is re-administered will approximately the same results be obtained. One of the contributing factors to unrealiable tests are controversial items, that is, items to which it is difficult to come to a decision. A research study by Hanley (1962) indicated that controversial items present more difficulty as measured by response latency and post-test judgments and items of high communality (i.e. items being answered in most cases in one direction).

Goldberg (1963) indicates that controversiality or instability of an item indicates ambiguity. Ambiguity is traditionally defined as uncertainty, or doubtfulness of the meaning of the stimulus. It often denotes a stimulus whose

meaning is open to various interpretations. Traditionally, the measure of this ambiguity has been intra-individual response variability or item instability. Goldberg (1963, p.47) contends that this is a serious error because

> items at the extremes of any attribute continuum have been shown to elicit less changes in responses than those reflecting positions in the middle range of the attribute...Since items seen by subjects as highly "ambiguous" can dischotomize the attribute continuum at many points, it is desirable to eliminate the effect of differences in endorsement frequency from the index of ambiguity.

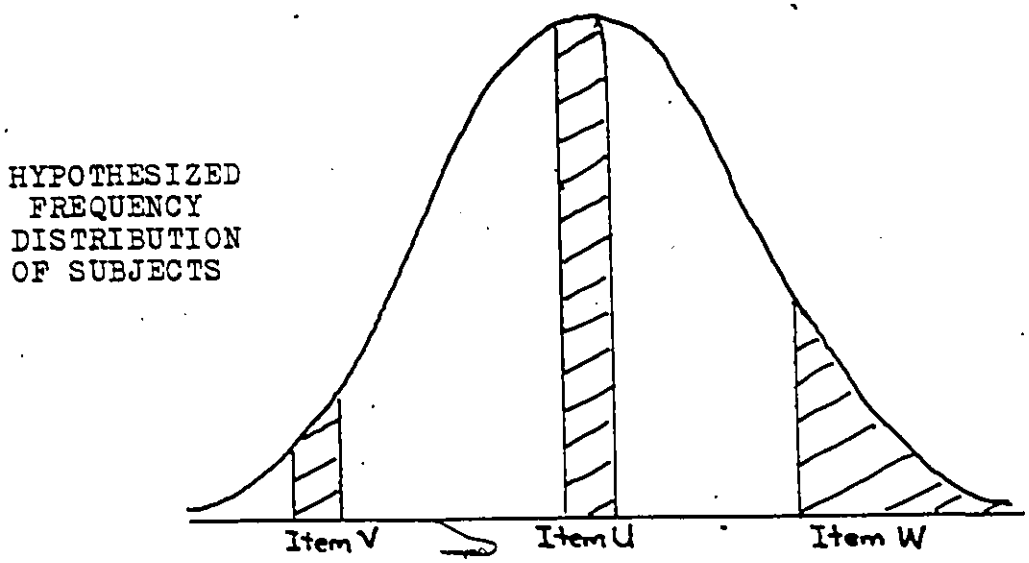
Goldberg, therefore, formulated an index of ambiguity for MMPI items based upon the percentage of response inconsistency "but which takes into account the effect of item imbalance."

Goldberg's index of ambiguity:

Goldberg talks about the "equivocality band" that is, the range of disagreement as to where the boundary of the item falls on the attribute continuum, in relation to ambiguity. If most people concur with respect to where they place the boundary of the item, this equivocality band is minimum. If half the people place the boundary at one end of the continuum and the other half place it at the opposite end, the "equivocality band" is maximum. Thus the wider the ambiguity band, the less stable the item and the narrower the ambiguity band, the more stable the item. Stability of response also depends on the "frequency density" at the item's

boundary point. If a person perceives himself close to the boundary of an item on a particular continuum, he will find it difficult to respond to the item when initially presented and will be inconsistent with respect to his response when it is re-administered. For this reason, items in the center as opposed to the extremes of the continuum are considered to be more difficult to answer for the average individual. Instability is considered, by Goldberg (1963), to be a characteristic of many items falling in the middle of an attribute continuum but ambiguity is not necessarily a characteristic of such an item. Instability is a function of both the content of the item and the subject's varying perception of his place on the continuum. If stability were equated with ambiguity, two items, one of which fell on the center of the continuum and the other at the extreme end, would not be considered equal in ambiguity due to the greater area of percentage change under the normal curve in the center of the continuum. Goldberg states that "it is desirable to eliminate the effects of differences in endorsement frequency..."(p. 470) in order to derive an index of ambiguity.

He attempts to explain these notions graphically in the following diagram.



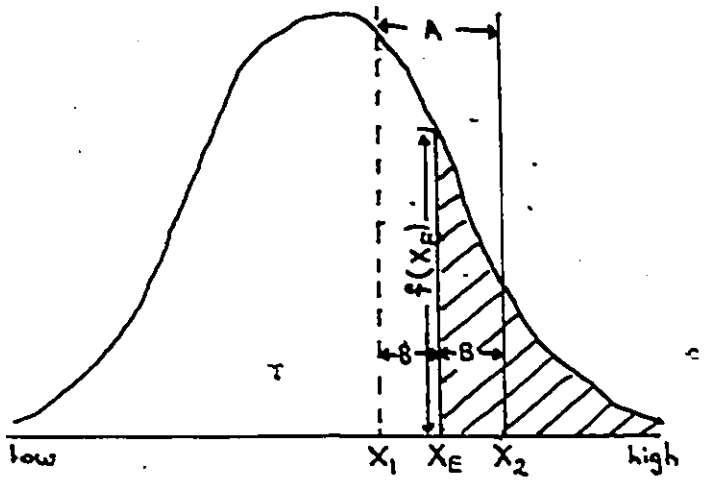
The shaded areas above each item represent the proportion of individual who had difficulty making a decision for the particular item. These are the persons most expected to change their responses upon repeated administrations of the item. As can be seen from Figure 3, although item W has a wide ambiguity band, owing to its extreme position on the attribute continuum it elicits about the same percentage change as item V, with the same width ambiguity band as item U, elicits the least percentage change (1963, p.476).

Because both items elicit the same amount of percentage change but different amounts of ambiguity, the correction for the item endorsement frequency is important.

If one presents an item pool to the same population twice, two measures can be obtained, the item endorsement frequency and the item instability. Goldberg uses these two measures to derive an index of ambiguity which indicates the width of the ambiguity band or range of disagreement of the item's

boundary on the attribute continuum. The following is the geometric rationale behind the ambiguity index, Amdex.

HYPOTHESIZED FREQUENCY DISTRIBUTION OF SUBJECTS



Where E = endorsement frequency (shaded area above)

A = Amdex

X_E = Scale value on the attribute continuum which cuts from the normal curve an area equal to the average endorsement frequency of the item.

$f(X_E)$ = ordinate of the normal curve erected at X_E.

X_1 and X_2 = Scale values on the attribute continuum such that

$$X_2 - X_1 = A$$

$$B = \tfrac{1}{2}A = X_2 - X_E \simeq X_E - X_1$$

1 = Average percentage of change (index of instability) taken as equal to the area under the normal curve between $X_E - B$ and $X_E + B$.

The ambdex is found by first defining the area of the rectangle : $I = A\, f(X_E)$ as equivalent to the associated area under the normal curve. Then $A = \frac{I}{f(X_E)}$

E. Response Sets

The assumption that subjects only respond to the content of an item is not an accurate one. According to Cronbach (1946, 1950) other variables, such as a person's set to respond in a particular manner regardless of the content, can influence test scores. Cronbach refers to this manner of responding as a response set, which is defined as

> ...any tendency causing a person consistently to give different responses to test items than he would when the same content is presented in a different form. (1946, p.476)

An example is an acquiescent person who answers questions in the "true" direction even when the item should be answered "false".

Some individuals may not normally refer to a response set when answering items but may do so when the item is ambiguous. We may have a number of different response sets: 1) acquiescence and negativism. Some subjects answer consistently in one direction -- true or false -- in a true-false situation regardless of the keying of the statement (Cronbach, 1946). 2) Speed vs. Accuracy. The subject's set determines whether he responds carefully or quickly

(Cronbach, 1946). 3) Social desirability: Some subjects present a socially desirable or undesirable picture of himself (Megargee, 1966).

A ccording to Messick and Jackson (1961) acquiesence, as determined by item desirability, plays a dominant role in personality inventories like the MMPI. These two factors influence the test scores to a great extent.

It appears that response set will not come into play when the social desirability of the item is neutral, the T-F alternatives are clearly defined and the item is concise and unambiguous. Content will be the important determinant. If one of these conditions is not satisfied, response set will play an important role in determining the answer to the item. The content of the item is important for the measurement of some construct and the response set could be important for the determination of the validity of the test.

F. The Purpose

The general purpose of this study is to investigate the pupillary responsivity of subjects classified as introverts and extraverts as they respond to ambiguous and non-ambiguous personality items. In particular, the design of this study is aimed at assessing the following hypothesis;

1) Do introverts and extraverts, as estimated by the Maudsley Personality Inventory, differ in pupillary response to ambiguous and non-ambiguous stimuli. A ccording to Eysenck,

extraverted and introverted individuals process information differently. It seems reasonable to give them ambiguous and non-ambiguous stimuli to ascertain if there is a physiological difference which corresponds to the psychological differences between introverts and extraverts.

In addition, the following is to be tested;

2) Using a Discriminant Function analysis, do other aspects of an individual's response along with pupil response add to the discrimination between introverts and extraverts.

The pupillary response measure will be the actual diameters of the pupils in millimeter form. Other measures taken during this study will be pupil diameters, during the control period before each stimulus, response latency which is the time in milliseconds between stimulus presentation and pupil response and percentage change scores. The percentage change score is the simplest of scaling techniques which in actuality equates the baselines for each subject while representing their pupil changes in percentage units in relation to their baselines. Average pupil size for each ambiguous and non-ambiguous including their respective controls, and overall mean pupil size for each subject are to be calculated and used in the study. In addition, subject's ratings of stimulus ambiguity and their PRF scores will also be included in the Discriminant Function analysis.

Since the mode of responding appears to influence pupil size, the subjects will be required to respond in three diff-

erent ways to items. Thus the effect of mode of response also can be assessed.

CHAPTER 2

METHOD AND APPARATUS

Selection of Subjects

Two hundred male psychology students at the University of Windsor were given the Maudsley Personality Inventory (MPI) in order to isolate extraverts (E) and introverts (I). Extraversion (E), neuroticism (N) and lie (L) scores were obtained for each subject. From the results of Eysenck's work (Jensen, 1958) extraverts were defined as those obtaining scores of 34 or more on the MPI and introverts were those subject's (Ss) obtaining scores of 20 or less on the MPI. Any S who had a score of more than 20 on the lie scale was rejected from the sample since the test scores were then of questionable validity. The total number of Ss selected for the ex periment was 48, that is, 24 extraverts and 24 introverts. Each of the groups was further subdivided into three groups comprised of eight subjects each. This subdivision was necessary in order to apply the experimental conditions differentially to each group. An attempt was made to match the three subgroups in each category (E and I) for their E-scores and N-scores. E, N, and age means and ranges for the six experimental groups are presented in Table 1. It can be seen from this table that there are no significant differences among the six groups along the neuroticism, extraversion and age dimensions. A number of "t" tests performed on the "E" scores indicate that groups 1, 2, and

TABLE I

E, N, and Age Means and Ranges of the Six Experimental Groups

		MEANS	RANGE
G1	E	38.500	34-48
	N	24.777	12-35
	A	22.875	20-28
G2	E	39.125	34-44
	N	25.000	12-38
	A	22.375	20-27
G3	E	38.295	36-44
	N	26.444	11-39
	A	22.250	19-28
G4	E	16.875	11-20
	N	24.444	14-36
	A	21.000	19-25
G5	E	15.375	10-20
	N	24.333	15-32
	A	20.375	17-23
G6	E	16.389	12-20
	N	24.777	14-34
	A	20.375	18-22

TABLE 2

Analysis of Variance of the Neuroticism Scores for Introverts and Extraverts in Three Experimental Groups

Source	SS	df	MS	F
Analysis 1				
Between groups: Introverts and Extraverts	15.1875	1	15.1875	0.2255
Experimental Error	3097.125	46	67.3288	
Analysis 2				
Extraverts Between groups: Condition 1,2,3	7.000	2	3.50	.0613
Experimental Error	1197.50	21	57.0238	
Analysis 3				
Introverts Between groups: Condition 1,2,3	13.000	2	6.500	0.0126
Experimental Error	1879.625	21	89.5059	

$F_{99}(1,46) = 7.25$ $F_{99}(2,21) = 5.78$

$F_{90}(1,46) = 2.83$ $F_{90}(2,21) = 2.58$

3 (High E groups) do not differ significantly from each other nor do groups 4, 5, and 6 (low E groups).

Since neuroticism is an important consideration, three single factor analysis of variance was run to see if any of the six groups differed significantly on neuroticism. The results of the three analyses are presented in Table 2. Since the critical F99 (1,46) = 7.25 and our F is .2255, we can accept the null hypothesis that extraverts and introverts do not differ along the neuroticism dimension. Similarly, we can accept the null hypothesis that there is no significant difference for the two dimensions (E and I) for the different conditions since in Analysis 2 and 3 the critical F99 (2,21) = 5.78 and our F ratios were .0613 and .0726 respectively. Therefore, none of the six groups differ on neuroticism. This lends support to the claim that extraversion and neuroticism as measured by the MPI are orthogonal (Jensen, 1958). The groups were well balanced for the relevent dimension. (Raw data presented in Appendix D).

Psychometric Instruments

The materials used were the Maudsley Personality Inventory (MPI), the Personality Research Form (PRF) and a rating scale for the items presented during the experimental session.

Maudsley Personality Inventory.

The MPI was developed by Eysenck to measure two of the three independent dimensions -- Introversion-Extraversion, Neuroticism and Psychoticism -- of the personality found through

factor analysis of many objective personality measurements. The development of the MPI has been described in great detail by Eysenck (1956b). Item analysis and factor analysis of other personality inventories, principally the Guilford inventory of factors STDCR and Maudsley Medical Questionnaire resulted in two factors and therefore two scales -- the E (Extraversion) and the N (Neuroticism) scales. The E-scale is best described as a measure of social extraversion or sociability, the N-scale as a measure of neurotic tendency and emotional stability and responsiveness. Both scales have high "construct validity," that is, the items making up the scales are highly correlated with the factor they are said to measure and do not correlate significantly with any other factor. The items of the two scales were selected so as to minimize the correlation between the two. Thus they are considered to be orthogonal.

The MPI consists of 24 E-scale items, 24 N-scale items, 20 Lie-scale items and 12 "buffer" items which were selected to conceal the nature of the questionnaire from the subject.

The type of item to which an extravert will usually answer - no and an introvert usually answer yes are as follows:

1) Are you inclined to keep quiet when out in a social group?

2) Are you inclined to limit your friends to a select few?

Also, extraverts are characterized by answering yes and

introverts no to the following types of questions:

1) Do you prefer action to planning for action?

2) Do you like to play pranks upon others?

These are the type of questions to which extraverts usually respond in a different manner than introverts. However, the total scale, not the performance on individual items, determines the score. According to Jensen (1965), none of the MPI items can be construed as socially objectionable. Jensen's results, in addition to split half and test-retest estimates ranging from .70 to .90, indicate that though brief, the Maudsley Personality Inventory is a reliable measure of extraversion-introversion and neuroticism. A sample of this test is presented in Appendix B.

Personality Research Form.

The Personality Research Form is a personality test developed by Douglas N. Jackson, at the University of Western Ontario, in 1967. The result of a careful perusal of Henry Murray's theory of personality was the development of 22 personality variables. There are several forms of the test. Form A and B are parallel tests each of which consist of 300 items divided into fifteen 20-item scales. Form AA and BB are parallel tests each consisting of 440 items divided into twenty-two 20-item scales.

The form used in the present research was form A which takes approximately 45 minutes to administer. The test can be easily hand scored and provides a profile of the following

variables:

1) Achievement - level of aspirations, competetiveness, resourcefulness and productivity.
2) Affiliation - level of companionability, geneality, co-operativeness and sociableness.
3) Aggression - aggressiveness, irritability and hostility.
4) Autonomy - independence, individualness, rebelliousness.
5) Dominance - level of ascendance, dominance and authoritativeness.
6) Endurance - persistence, determination and zealousness.
7) Exhibition - level of conspicuousness, and expressiveness.
8) Harmavoidance - adventurousness, vigilance and cautiousness.
9) Impulsivity - spontaneity, recklessness and impetuousness.
10) Nurturance - benevolence and charitability.
11) Order - organization and discipline.
12) Play - frivolousness and joviality.
13) Social Recognition - courteousness, and need for respectability and recognition.
14) Understanding - curiosity and inquisitiveness.
15) Infrequency - items answered in an implausible direction, thus, indicating random method of answering, carelessness, gross, or poor comprehension.

Although a relatively new test, it is considered to be very reliable and valid. The authors defined each of the variables stringently before attempting to formulate the scales.

Items were selected very carefully to ensure homogeneity. They also followed Loevinger's (1957) suggestions concerning the necessary elements for a valid and reliable test. Empirical evaluation of the test indicate the following: 1) standard deviations are large; subjects are separated well on the scales; 2) reliabilities are unusually high for personality scales. The medium reliability is .92 with a range of .89 to .94.

The PRF was used to see if any other personality variables were factors in the type and amount of pupillary responsivity.

The Rating Scale.

A simple rating scale was developed and administered to each S in conditions 1 and 2 after the experimental session. This scale was composed of the 24 experimental items, 12 of which were classified as ambiguous and 12 as non-ambiguous items. They were asked to rate the items on a seven-point scale representing a continuum from "extremely clear" to "extremely unclear". The purpose was to obtain the subject's perception of the ambiguity content of the presented items. The ratings for the 20 experimental items only were used in the data analyses. A sample of this form is presented in Appendix B.

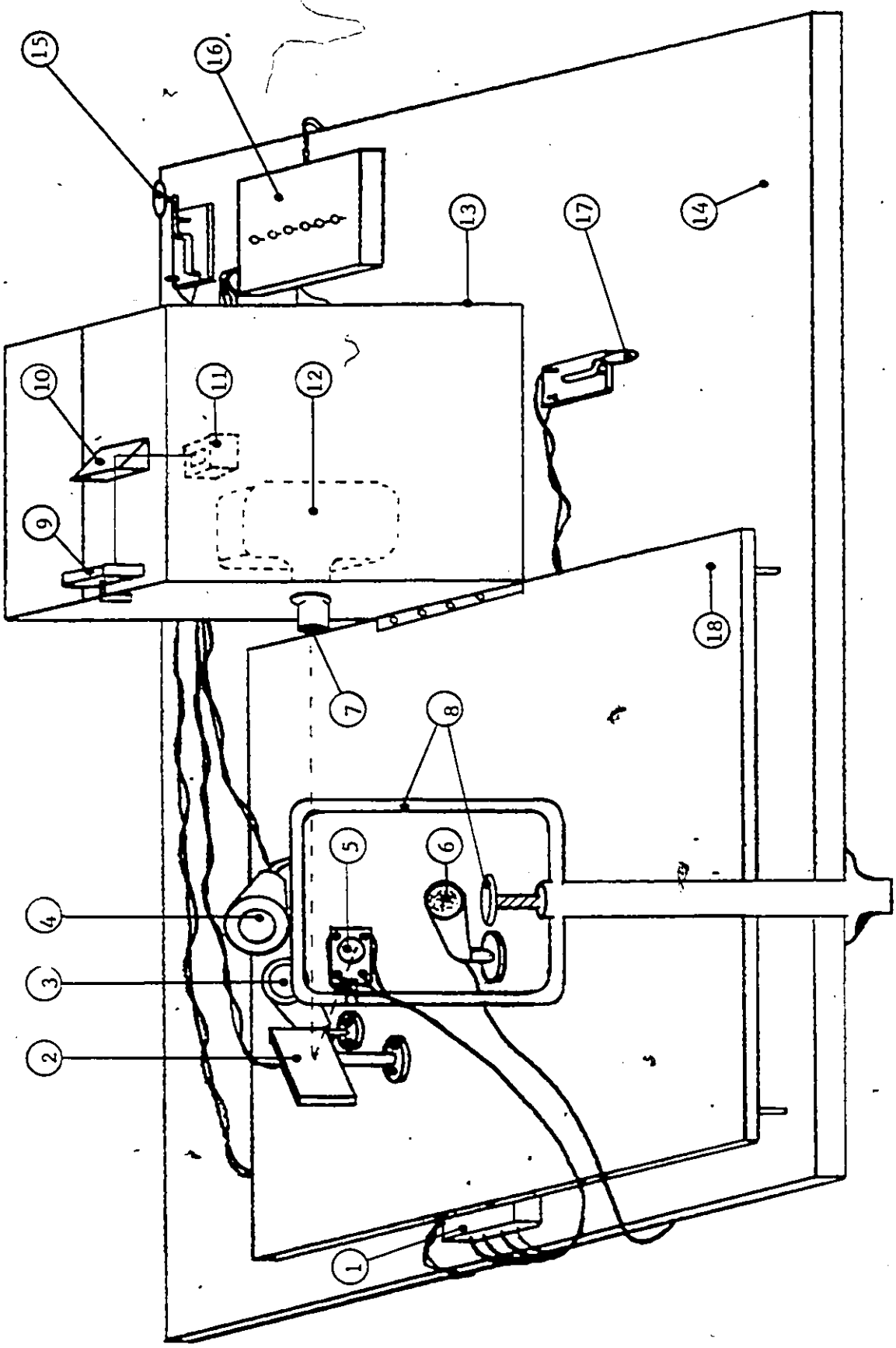
Apparatus

The apparatus used in this experiment consisted of a 16 mm camera with infrared film, a projector and a set of stimulus slides, an infrared light, a focus light, an adjustable chin-

rest, two key-presses and a reflector to light the room. The apparatus was a modification of that used by Sweeney (1968) and Anderson (1968). Some of the modifications involved the use of fiber optics as markers on the film, the use of a photocell, and a microphone. The photographic apparatus is presented in Figures 1 and 2 and a more detailed technical description can be found in Appendix A.

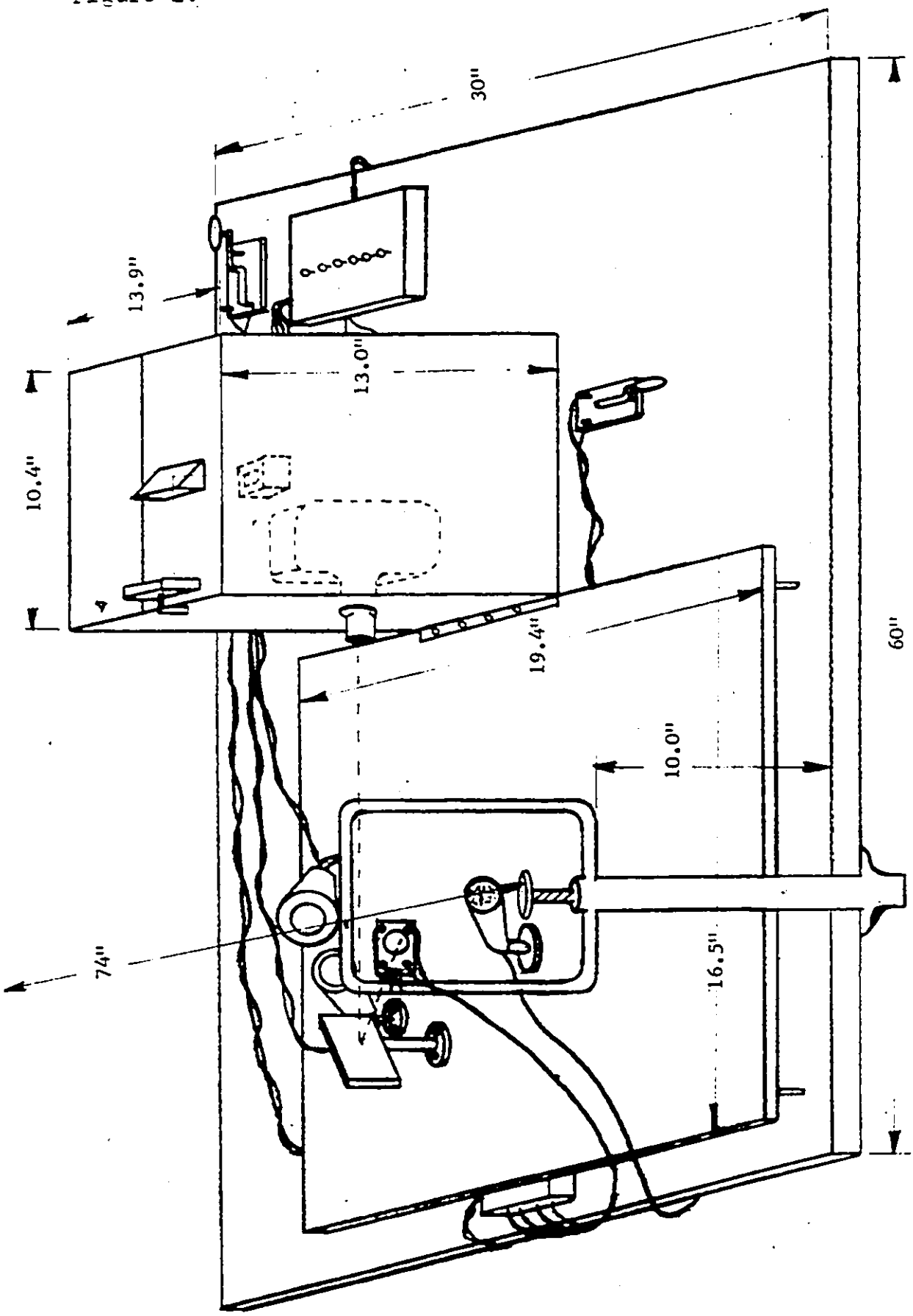
The apparatus rested upon a table .35 high and 60 inches long by 30 inches wide. The apparatus consisted of two basic sections: an adjustable base measuring 19.5 inches wide by 16.5 long and a box enclosing the camera, and measuring 10.9 inches long by 14 wide and 13 inches high. These two sections were connected by a number of metal hinges with the camera box to the right of the adjustable base. The adjustable base was placed at a position one inch from the edge of the table to allow room for the adjustable chin-rest which was attached directly to the table at a position 8.9 inches from the left edge of the base. The Bausch and Lomb chin-rest could be adjusted so that the maximum height of the chin-cup is 12.6 inches from the table and the minimum was 11.6 inches from the table. To the U-shaped bar surrounding the apparatus was attached a 3.5 in. by 1.6 in. piece of plastic with a circular hole having a diameter of 1.5 inches. In the four corners of the plastic close to the hole were attached four lengths of fiber optics which terminated in a metal box 6 inches wide by 10 inches long by 2.25 inches high containing

Figure 1.



Pupillometric Apparatus - Close-Up View

Figure 2.



Pupillometric Apparatus - Close-Up View

Pupillometric Apparatus

Legend

1. indexing light control box
2. front surfaced mirror
3. infra-red light
4. focus light
5. plastic fibre optic light guides with clear plastic eye piece
6. microphone
7. camera lens
8. adjustable chin rest and head restrainer
9. frame counter mirror
10. right angle frame counter prism
11. frame counter
12. camera
13. camera box
14. table
15. E's indexing key
16. control console
17. S's response key
18. apparatus base-adjustable
19. projector
20. photocell
21. projection area
22. S's chair - adjustable
23. projection reflecting mirror
24. reflector flood lamp

four bulbs. Each of these bulbs were connected to one of four pieces of apparatus: a microphone, one of two key-presses and a photocell which registered the onset and termination of the projected slide. The activation of one of these components (i.e. microphone, etc.) completed an electric circuit which light up a corresponding bulb. The light from the bulb passed through the optical fiber illuminating its tip which then could be recorded on the film. The result was that the point at which a person spoke (sensed by microphone) or the pressing of the key-press or the onset or termination of the projected slide was recorded as a dark spot appearing in the appropriate corner of the film. This is portrayed in Figure 3.

The microphone, mirror, focus light and infra-red light were mounted on the adjustable base. The front surface mirror, the top edge of which was 9.75 inches from the base and measured 4 inches long by 3 inches wide, was to the left of the chin-rest (in relation to the subject) and in line with the lens of the camera. The infra-red light was positioned slightly ahead of and to the left of the focus light which was directly in line with the chin-rest. They were positioned in such a way that they could readily illuminate the left eye of the subject when required. The brand name and serial number of the infra-red light was Monolux 110-20 WR and the voltage and wattage of the bulb used were 110 and 20 respectively. A 25 watt bulb in a reflector was used as

Figure 3. Film Negative of Eye Illustrating the Set-up of the Fiber Optic System.

the focus light. The microphone, a Shure Model 540 S was placed directly in front of the chin-rest and was connected to an amplifier which was adjusted to a suitable volume to complete the circuit for the optical fibers.

A Bolex H 16 Reflex camera regulated to a rate of 20 frames per .12 seconds and a frame counter were located in the box to the right of the adjustable base. The electrical circuitry and the mechanical make-up of the pupillometric apparatus is presented in Appendix A. The box was equipped with two adjustable legs in order to adjust its height to the height of the adjustable base which was 4.4 inches from the table at the chin-rest end and 1.75 inches at the focus light end. Kodak high speed 16 mm. infra-red film was used in the camera. A 100 mm. lens with an aperture of 4.0 protruded horizontally through a circular opening in the box. The focus length of the camera was 11 inches from the lens to the mirror and 11 inches from the mirror to the plastic eye-piece -- the total length being 22 inches. The frame counter was attached to the interior of the box and exposed to view through a small narrow opening in the top of a box. The opening was covered by a right angle prism which cast the reflection of the frame counter immediately to the left into a mirror from which the frame numbers could be recorded by the experimenter.

Two key presses were mounted on the table. One was positioned to the right of the subject and the other to the

right of the experimenter. Both were connected to the optical fibers. During the present experiment the subject's key press was not used. The experimenter used his if something happened and he wished to note the exact point of its occurrence. A control panel was placed beside the camera box and to the right of the subject. It consisted of one main switch which activated the camera, projector and infra-red light at the same time and an individual switch for these three and one for the focus light.

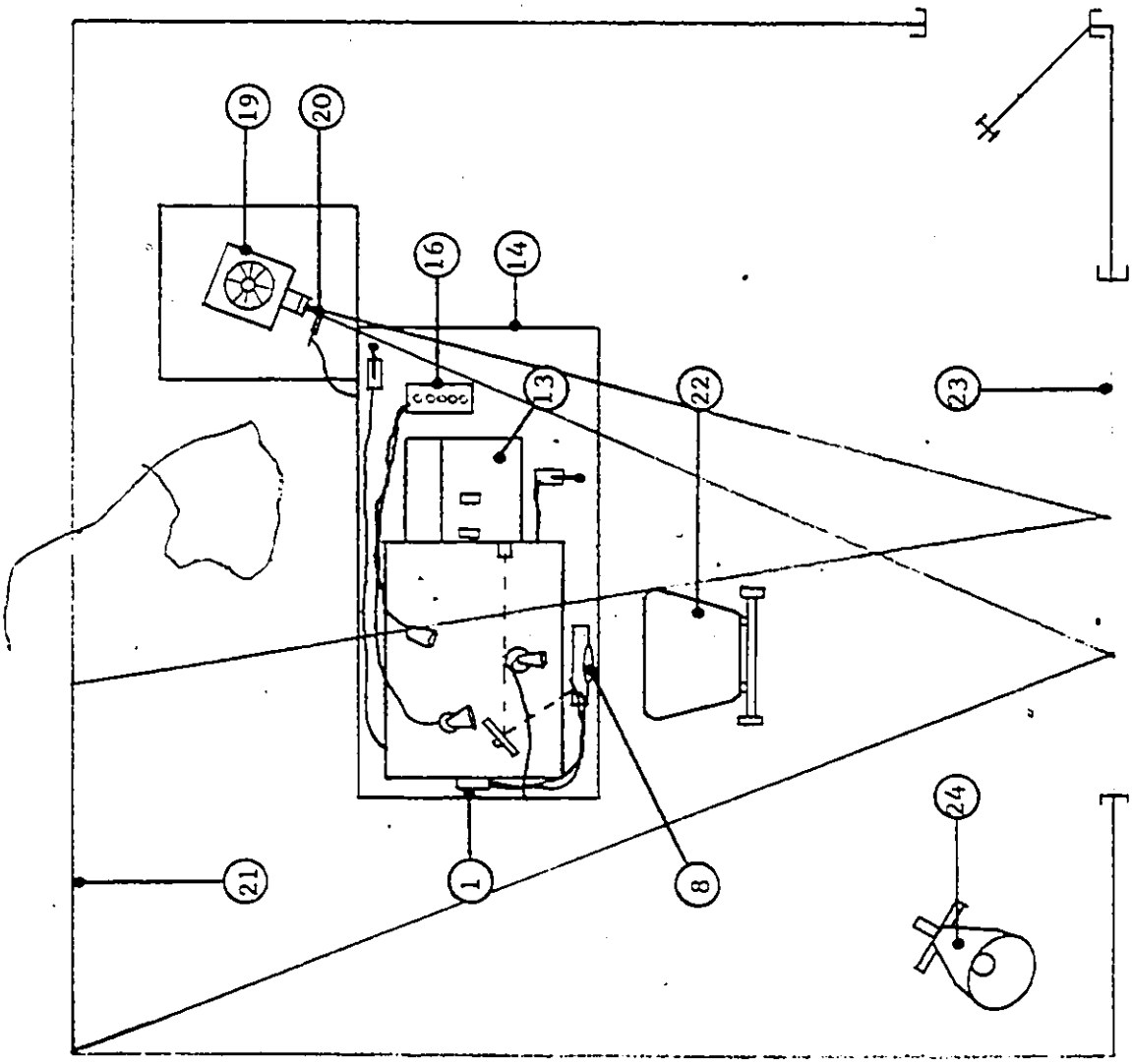
The experimental room was 107.25 inches wide by 120.25 inches long by 110 inches high and was lighted by a single light which was 64 inches from the floor. A 100 watt bulb was used in the reflector which was 10.5 inches in diameter. An automatic Kodak Ekatgraphic Model E slide projector was used with a 5 inch 3.5 Kodak projector Ektanar lens. Two timers (Hunter, Model 100 C and 111 C) were used to make the timimg of the slides precise. These were set at .500 seconds (max. 10 sec.) and 12.00 seconds (max. 100 seconds) respectively. The projector was placed on a table at a height of 62 inches and placed in front of but far to right of the subject. The projector and the top table were screened so that they did not attract the subject's attention unduly. When the subject was looking at the slides, this piece of apparatus was not in his direct line of focus. The projector was flat on the table but directed toward the one-way mirror on the back wall (behind the subject) of the room and

reflected off this onto the front wall (the wall the subject was facing). The distance from the lens to the mirror was 92 inches and from the mirror to the wall, 131 inches. The distance from the head of the subject to the slide area on the wall was 74 inches and the slide area projected onto the wall in front of the S was 55 inches by 37.5 inches. The photocell was placed just in front of the projector lens in such a way that the onset of the projected slide completed the circuit and illuminated the appropriate bulb and optical fiber and the termination broke the circuit and terminated the light. An overhead view of the experimental setting is presented in Figure 4.

Items

The stimulus items were typed on paper and were made into slides by photographing it at an aperture of 5.6. The reflector flood light was reflected off the ceiling and back wall so that the mean illumination of the perimeter of the slide areas was 15.1653 footcandles with a standard deviation of 0.0938 footcandles; the mean illumination of the control slide areas was 15.7201 footcandles with a standard deviation of 0.08.2; the mean illumination of the experimental slide areas was 15.7533 footcandles with a standard deviation of 0.2304 footcandles. Thus the mean differences in illumination between the perimeter and control slide areas and the perimeter and the experimental slide areas was 0.5549 foot-candles and 0.5881 footcandles respectively. There was

Figure 4.



Pupillometric Apparatus - Overhead View

no difference between the slide areas for the control and experimental slides, as is indicated by a t-score of 0.5904.

The contrast component was minimized because of the changes in pupil size associated with changes in contrast, that is, when the S looks from a dark areas to a bright area. To minimize the contrast between the wall and the slide, the slide area was made very large, so that the S very rarely would focus on the wall. The slide should have always been the area of focus. Also to effectively cut down the contrast, the print on the slides were a grey toned print as opposed to a black-toned print. The footcandle differences of 0.5881 and 0.5549 between the perimeter and slide areas of the experimental and control slides respectively demonstrate that the differences in brightness were not large.

Twenty control slides and twenty experimental slides were used during the experimental period. The control slide had two rows of "X's" across the center of the slide as though it were a two-lined sentence. The control slides and experimental slides were, thus, matched for contrast and brightness as closely as possible.

Wiggins' "Manual for the MMPI item characteristic deck" was used to select the 20 experimental items from the MMPI. Half the items were classified as being high in ambiguity according to Goldberg's ambiguity index, Amdex (1961) and the other half as being low in ambiguity. Two practice and buffer items were selected from the middle range of ambiguity and social

desirability. The range for high ambiguous was 76 to 109 and for low ambiguous was 00 to 35. Item desirability was controlled for by selecting only items falling between 350 and 670 on the nine point desirability scale constructed by Messick and Jackson (1961). An attempt was also made to match ambiguous and non-ambiguous items for overall mean of the social desirability rating and the number of letters in the item. To control for "response set", the scale developed by Hathaway and McKinley (1951) was used so that in both the ambiguous and non-ambiguous category, five items were keyed as being answered "true" least frequently by Minnesota Normals and the other five as being answered "false" least frequently by Minnesota Normals. All the items are presented in A ppendix C.

At the beginning of the first few films, a millimeter ruler was photographed and a magnified millimeter ruler was made. When the processed film was placed on a Dogmar Super, Model A, Micro-film Reader which was raised to a height of 18 inches in order to magnify the image, the maximum amount, the recordings of the pupil size were measurements of the actual size not of the magnified size.

Procedure

The 48 male subjects were divided into two groups -- extraverts and introverts -- which were devided into three experimental subgroups of eight subjects each. Each subject was tested indfvidually by the same experimenter. A Total

of twenty-four control slides and twenty-four experimental slides were presented to each S. Each experimental slide was always preceded by a control slide. During the control period, eye movement was controlled by instructing each subject to "read" the X's on the slide to himself as long as the slide was present. Each slide appeared for 12 seconds with a one-second interval between slides, that is, exchange time.

The subject was seated at the table on which the apparatus was placed. The general purpose and function of the apparatus was explained briefly. The subject was asked to place his head in the chin-rest and asked if the chair was placed at a comfortable height. If the chair was not at a comfortable height, it could be raised or lowered until the subject felt comfortable and was not straining his neck. He was told that crossing his arms would make the position more comfortable. After he was positioned, the image of the subject's left eye was focused in the camera with the aid of the focus light adjusting the chin-rest so that all four fiber optics were clearly seen in the four corners. The foxus light was then switched off and the subject was requested to relax while the instructions pertaining to his group were presented.

There were three response modes corresponding to the three experimental subgroups: (1) Verbal -- "True" or "False"; the subject responded to the experimental items with an overt "true" or "false" answer; (2) Verbal --

"Now", the subject gave no specific "true" or "false" answer but responded by saying "now" indicating that he had arrived at either a "true" or "false" answer, (3) No Response, the subject refrained from responding in any manner whatsoever and was also instructed to read the item over and over again to himself for as long as it was presented.

The following are actual instructions given for each response mode. These are the same instructions used by Sweeney (1968) and Anderson (1968) with some slight modifications.

Condition 1: Verbal-"true" or "false"

> On the wall directly in front of you a number of statements will be projected. Please read each statement and decide whether it is true as applied to you or false as applied to you. Each statement will be presented for 12 seconds during which time you will make a response of "true" or "false". If a statement is true or mostly true, respond by saying "true". Similarly if a statement is false or not usually true as applied to you, respond by saying "false". Remember to give your own opinion of yourself and make your response while the item is being presented .
>
> Each statement will always be preceded by a slide with 2 rows of X's printed on it. These slides will also be presented for 12 seconds. Look at these slides and X's. Please do not move your head once it has been positioned on the chin-rest. This is very important.
>
> You will now be given 2 practice items to familiarize yourself with the procedure. Be sure to speak loud.

Condition 2: Verbal-"Now"

> On the wall directly in front of you a number of statements will be projected. Please read each statement and decide whether it is true as applied to you or false as applied to you. Each statement will be presented for

12 seconds. If a statement is true or mostly true, answer to yourself "true", and respond by saying "now" immediately. Similarly, if a statement is false or not usually true, answer to yourself "false" and indicate this by saying "now" immediately. In other words, indicate once you have made a decision as to whether the item applies or does not apply to you by saying "now". Remember to make your response while the item is being presented.

Each statement will always be preceded by a slide with 2 rows of X's. These slides will also be presented for 12 seconds. Look at these slides and merely read the X's on them to yourself as long as the slides are presented. Please do not move your head once it has been positioned on the chin-rest. This is very important.

You will now be given 2 practice items to familiarize yourself with the procedure.

Condition 3: No Response

On the wall directly in front of you a number of statements will be projected. Each statement will be presented for 12 seconds. Please read each statement over and over again for as long as it is presented to you but be very sure not to answer the item in any way. Simply read the statement over and over again to yourself but do not decide whether the item is applicable to you and do not answer in any manner whatsoever.

Each statement will always be preceded by a slide with 2 rows of X's printed on it. These slides will also be presented for 12 seconds. Look at these slides and merely read to yourself as long as the slide is presented. Please do not move your head once it has been positioned on the chin-rest. This is very important.

You will now be given 2 practice items to familiarize yourself with the procedure.

A brief question period followed the instructions to insure that the S understood the directions. The subject was then requested to pla ce his chin on the chin-rest. The focusing and positioning of the eye was checked and any

adjustments made before the focus light was switched off. The projector and infra-red light were switched on simultaneously in order to present two practice experimental items with their respective controls in the normal procedure. At the conclusion, the apparatus was switched off and the subject was asked if there were any further questions. When the experimenter was satisfied with the subject's understanding of the situation, he was requested to place his chin on the chin-rest again. The experimenter, again, checked the focusing of the eye by switching on the focus light and checking the image on the camera. The focus light was switched off and the camera, projector and infra-red light were switched on simultaneously. The first two experimental slides were used strictly as buffer items in that their function was to familiarize the subject with the operation of the camera and to control for the novelty of the situation. The photographs of the eye taken during this period were not used in the calculation of measurements. There was no interruption between the buffer period and experimental during which the ten embiguous and ten non-ambiguous items were presented in a different random order for each subject.

After the actual experimentation, the subjects in the two verbal conditions filled out the rating scale for the experimental items. The subjects were also asked to participate in another phase of the experiment which could take

place at any time that was convenient for them -- this involved the taking of the PRF.

Several different measures were used in the analyses. The raw scores -- the actual millimeter values -- were used for each subject. Proportion scores were also used. The mean of the 20 frames taken during the presentation of the control slide was computed and each of the 20 frames taken during the presentation of the following experimental slide was compared to this mean or baseline in terms of proportion. For example, if the mean of the 20 frames taken during the presentation of a control was 4.6 and one of the immediately following experimental frames was 4.8, the proportional change from the baseline was .2/4.6 or 2/46 or .043. In the actual computation, this became 1.043 since the value "one" was added to each score value in order to avoid negative numbers. Mean pupil size for the control items, and the experimental items for both Ambiguous and Non-ambiguous stimuli were calculated. In addition an overall mean pupil size for each subject was determined. The mean difference between slide presentation and response in milliseconds for ambiguous and non-ambiguous stimuli was also used in the analyses.

Both direct andstepwise Discriminant Function Analyses were used on the collected data. The SPSS computer programming package was used. The .05 level of confidence was chosen as the critical level indicating the statistical significance of this study.

CHAPTER 3

RESULTS

An analysis of variance was used to ascertain whether introverts and extraverts differ in pupillary response to ambiguous and nonambiguous stimuli. This analysis of the differential pupil size (using actual size in millimeters) of extraverts and introverts to ambiguous and non-ambiguous experimental items indicates that there is no significance for main effects or interaction at the .05 level. The summary of the analysis of variance is presented in Table 3. There is a tendency towards significance for an interaction between ambiguity and extraversion-introversion. An analysis of simple effects yielded no significant simple effects although introverts tended to have a larger mean pupil size than extraverts as is represented graphically in Figure 5.

The accumulated data was punched on IBM cards and subjected to computer processing using the Statistical Package for the Social Sciences (SPSS). Table 4 contains a list of the variables and their respective abbreviations used in the program. Both the direct and stepwise methods of the discriminant function package of SPSS were utilized.

Table 5 lists the variables used with their corresponding Wilks' lambda and univariate F-ratio for the direct analysis which used pupillary data only as the discriminating variables. This direct analysis yielded standardized discriminant function coefficients, unstandardized

Table 3

Analysis of Variance of Mean Score Values for the Effect of Response Mode, Ambiguity and Extraversion - Introversion on Mean Pupil Size for Experimental Items

Source of Variation	SS	df	MS	F
Between Subjects	90.9278	47		
A (Response mode)	0.2058	2	.1029	.048
C (Extraversion-Introversion)	0.9385	1	.9385	.440
AC	0.2495	2	.1248	.059
Subjects within groups	89.5340	42	2.1318	
Within Subjects	.3582	48		
B (Ambiguity)	.0003	1	.0003	.041
AB	.0001	2	.0001	.007
BC	.0268	1	.0268	3.446
ABC	.0043	2	.0022	.279
B x subjects within groups	.3267	42	.0078	

F_{95} (1,42) = 4.07 F_{95} (2,42) = 3.21

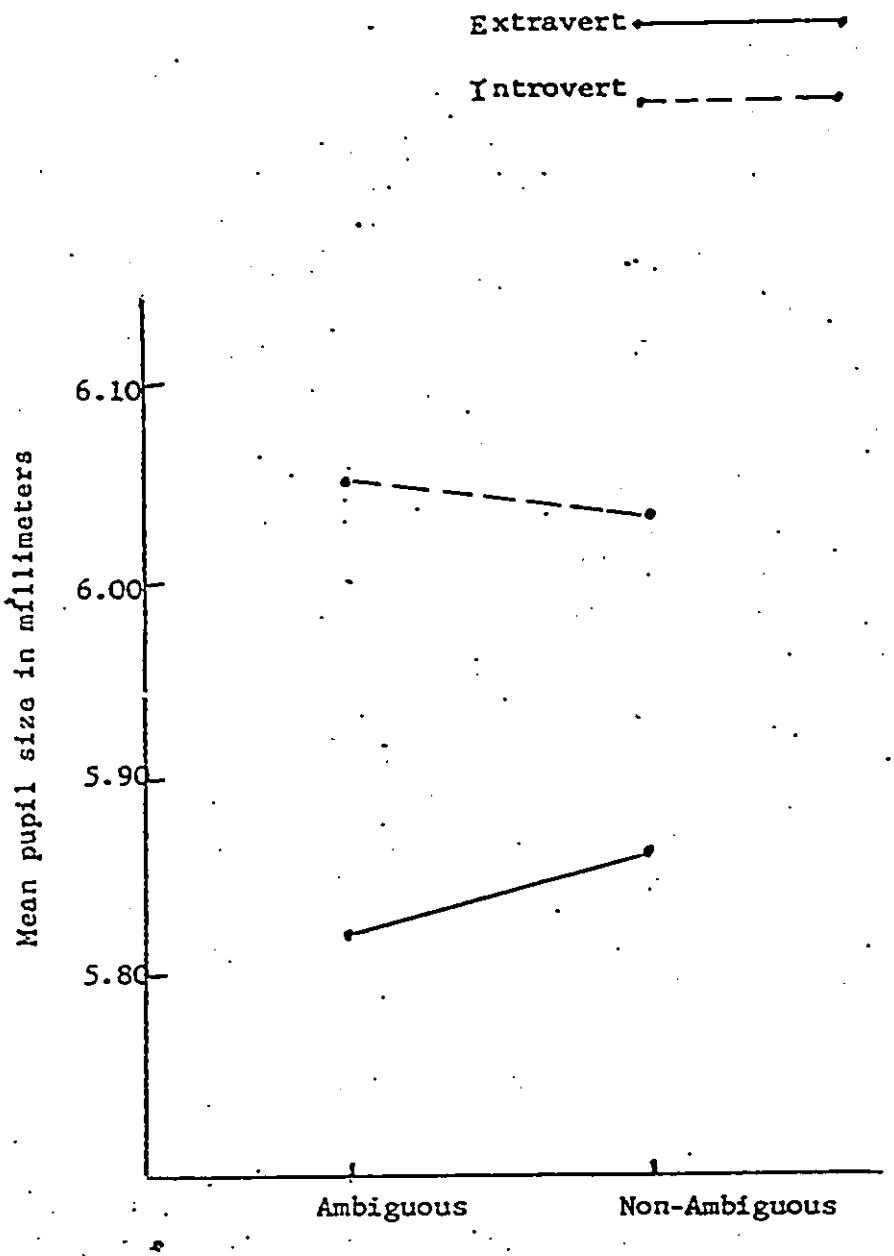


Figure 5. Mean pupil size of extraverts and introverts for ambiguous and non-ambiguous items.

Table 4

Program Abbreviations and Corresponding Variable

Abbreviation	Discriminating Variable
PSAMB	Mean pupil size to ambiguous items.
PSNAMB	Mean pupil size to non-ambiguous items.
PSCAMB	Mean pupil size to control slides preceding ambiguous items.
PSCNAMB	Mean pupil size to control slides preceding non-ambiguous items.
PRAMB	Mean proportional pupil change between control slides and ambiguous items.
PRNAMB	Mean proportional pupil change between control slides and non-ambiguous items.
OPSAMB	Mean overall pupil size to ambiguous items and their respective controls.
OPSNAMB	Mean overall pupil size to non-ambiguous items and their respective controls.
TOT	Mean overall pupil size to ambiguous and non-ambiguous including controls.
LATAMB	Mean time between onset of ambiguous items and pupil change.
LATNAMB	Mean time between onset of non-ambiguous items and pupil change.
SUBAMB	Mean subjective rating of ambiguity for ambiguous items.
SUBNAMB	Mean subjective rating of ambiguity for non-ambiguous items.
AC	PRF scale- achievement.
AF	PRF scale- affiliation.
AG	PRF scale- aggression.
AU	PRF scale- autonomy.
DO	PRF scale- dominance.
EN	PRF scale- endurance.
EX	PRF scale- exhibition.
HA	PRF scale- harmavoidance.
IM	PRF scale- impulsivity.
NU	PRF scale- nurturance.
OX	PRF scale- order.
PL	PRF scale- play.
SR	PRF scale- social recognition.
UN	PRF scale- understanding.
LN	PRF scale- infrequency.

Table 5

Wilks' Lambda and Univariate F-Ratio

for the Direct Method

with Pupillary Variables

Variable	Wilks' Lambda	Univariate F-Ratio (1,30d.f.)
LATAMB	0.9976	0.0735
LATNAMB	0.9864	0.4122
PSAMB	0.9851	0.4522
PSNAMB	0.9910	0.2717
PSCAMB	0.9763	0.7274
PSCNAMB	0.9821	0.5462
PRAMB	0.8686	4.5370*
PRNAMB	0.9719	0.8683
OPSAMB	0.9809	0.5854
OPSNAMB	0.9868	0.4005
TOT	0.9839	0.4895

*significant at .05 level

discriminant function coefficients and group centroids for the one discriminant function. These are contained in Table 6. The direct method yielded a discriminant function with an eigenvalue of 0.74125 and a canonical correlation equivalent to 0.652. In addition, the Wilks' lambda for all variables included in the analysis was 0.5743 with converted chi-square of 14.142 which was significant at the 0.117 level, with 9 degrees of freedom. Using the discriminant function coefficients, prediction of the original sample was also completed. The results of this prediction are contained in Table 7. From Table 7, it can be seen that the discriminant function was able to correctly classify 43.8% or 7 of the subjects originally classified as extraverts by the MPI, 75% or 12 of the introverts with overall correct classification of 59.38%.

The stepwise method with pupillary variables alone yielded a discriminant function using only one variable, the proportional mean pupil size change for the ambiguous items. The remainder of the variables originally included in this analysis did not meet the program's entry criterion and therefore they were excluded. The unstandardized discriminant function coefficients and group centroids for this discriminant function are included in Table 8. This discriminant function had an eigenvalue of 0.0000 and a canonical correlation equivalent to 0.001. The Wilks' lambda was 1.000 with converted chi-square of 0.0 which

Table 6

Discriminant Function Coefficients

and Group Centroids

For the Direct Method

with Pupillary Variables

Variable	Standardized Coefficient	Unstandardized Coefficient
LATAMB	0.29121	0.01812
LATNAMB	-0.44363	-0.02905
PSAMB	17.35493	17.38104
PSNAMB	-49.75113	-49.10437
PSCAMB	14.01012	13.79781
PSCNAMB	50.12329	47.48077
PRAMB	7.36700	285.26074
PRNAMB	-0.80785	-27.04272
OPSAMB	-28.08514	-27.95580
CONSTANT		-267.50269

Group	Centroid
Extravert	0.11397
Introvert	-0.11029

Table 7

Prediction Results Using Function Derived from Direct Method with Pupillary Variables

Actual Group	Cases	Predicted Group Membership	
		Extravert	Introvert
Extravert	16	7 or 43.8%	9 or 56.3%
Introvert	16	4 or 25.0%	12 or 75.0%

Overall Correctly Classified= 59.38%

Table 8

Unstandardized Discriminant Function Coefficients and Group Centroids for the Stepwise Method with Pupillary Variables

Variable	Unstandardized Discriminant Function Coefficient
PRAMB	38.72141
CONSTANT	-39.77641

Group	Centroid
Extravert	0.34377
Introvert	-0.34354

which was not significant. Prediction of the original sample using the discriminant function coefficients was also completed. This discriminant function accurately predicted 9 or 56.3% of the subjects originally classified as extraverts, 62.5% or 10 of the introverts with an overall correct classification of 59.38%. (see Table 9)

Two other stepwise discriminant functions were also derived using the SPSS program. The first of these used PRF scores and pupillary data as discriminating variables: the other analysis used the PRF scores as discriminating variables. A comparison of the results of these two analyses, alongwith the stepwise discriminant function results with pupillary variables alone, can be found in Table 10.

The statistics indicate that the discriminant function yielded using both pupillary plus PRF variables was significant since it had a Wilks' lambda of 0.2722 with chi-square of 34.485 (d.f.=7) which was significant at the 0.000 level. In addition, this discriminant function is relatively important given its eigenvalue of 2.67412 and its variance of the original variables of 72.8% derived from its canonical correlation of 0.853. Even the centroid difference of 1.67938 and the overall prediction accuracy of 96.88% indicate that the discriminant function yielded when both pupillary and PRF variables were included, is significant.

Similarly, using PRF variables as discriminating variables provided a discriminant function which was

Table 9

Prediction Results Using Function Derived from Stepwise Method with Pupillary Variables

Actual Group	Cases	Predicted Group Membership Extravert	Introvert
Extravert	16	9 or 56.3%	7 or 43.8%
Introvert	16	6 or 37.5%	10 or 62.5%

Overall Correctly Classified= 59.38%

Table 10

Comparison

of

Stepwise Discriminant Function Analyses

	Pupillary Alone	Pupillary + PRF	PRF Alone
Eigenvalue	0.0000	2.67412	1.78594
Canon. Correlation	0.001	0.853	0.801
Lambda	1.0000	0.2722	0.3589
Chi-square	0.0	34.485	27.664
Significance of chi	1.000	0.000	0.000
Centroid Difference	0.69131	1.67938	1.57610
Prediction Accuracy			
Extravert	56.3%	93.8%	81.3%
Introvert	62.5%	100.0%	93.8%
Overall	59.38%	96.88%	87.50%
Number of Variables	1	7	6
Variables	PRAMB	LATAMB	AF
		LATNAMB	AU
		AC	EX
		AF	IM
		AU	NU
		EX	OX
		IM	

significant; however, this significance was not as great as the levels of the function derived using all of the variables. (both PRF and pupillary)

CHAPTER 4

DISCUSSION

The first hypothesis asked if the extraverts and introverts differed with respect to their responsivity to ambiguous and non-ambiguous items. Using the actual pupil sizes as the data for the analysis, there was no significant difference between extraverts and introverts for the two types of items.

The second hypothesis questioned whether pupillary measures or pupillary measures alongwith PRF scores would significantly discriminate extraverts and introverts.

Discriminant analysis begins with the desire to statistically distinguish between two or more groups of cases. In the first two analyses of the present study, two groups, extraverts and introverts as determined by the individual subject's score on the MPI, were to be discriminated on the basis of pupillary measures. Mathematically, the objective of discriminant analysis is to weight and linearly combine the discriminating variables in some fashion so that the groups are forced to be as statistically distinct as possible. Discriminant analysis attempts to do this by forming one or more linear combinations of the discriminating variables. These discriminant functions are of the form

$$D_i = d_{i1}Z_1 + d_{i2}Z_2 + \ldots + d_{ip}Z_p$$

where D_i is the score on discriminant function i, the

d's are weighting coefficients and Z's are the standardized values of the p discriminating variables used in the analysis. The maximum number of functions which can be derived is either one less than the number of groups or equal to the number of discriminating variables, if there are more groups than variables. In the analyses of the present study, since there were only two groups, only one discriminant function for each analysis was derived.

According to the SPSS manual, the direct method of discriminant function analysis is appropriate when the researcher wishes to have all the independent variables entered into the analysis. The alternative to the direct method is to use a stepwise selection method. In the latter case, independent variables would be selected for entry into the analysis on the basis of their discriminating power. Often the full set of independent variables contains excess information about the group differences or possibly some of the variables may not be very useful in discriminating among the groups. By using a stepwise method, a reduced set of variables will be found which is almost as good as and sometimes better than, the full set.

Using the statistics provided in the program it is possible to ascertain if either the direct or the stepwise methods provide more significant results, or if the discriminant function is significant at all.

The group centroid is one measure of the significance of the discriminant function derived. The centroid is obtained by averaging the discriminant scores for the subjects within a particular group. The discriminant scores for each subject are obtained by multiplying the particular unstandardized coefficients by the corresponding discriminating variable score for each subject and summing the results alongwith the constant derived by the program. Consequently, a comparison of group means or centroids on a discriminant function tells one how far apart the groups are along that dimension.

In the direct method in this study with the pupillary data exclusively, all of the discriminating variables yielded a difference spatially of only 0.224 (0.114 + 0.110) between the extraverts and introverts. The stepwise method with pupillary data exclusively yielded a separation of 0.688 (0.344 + 0.344) using only the variable of pupil change for the ambiguous items. Clearly, on the basis of the centroid differences, the coefficients resulting from the stepwise method with pupillary data alone resulted in more discrimination between groups. This can be seen by comparing Figure 6 and Figure 7 which contain the centroids and plots for subjects within each group.

From Figure 6 and 7 it can be seen that both methods produced an extreme degree of intermingling between

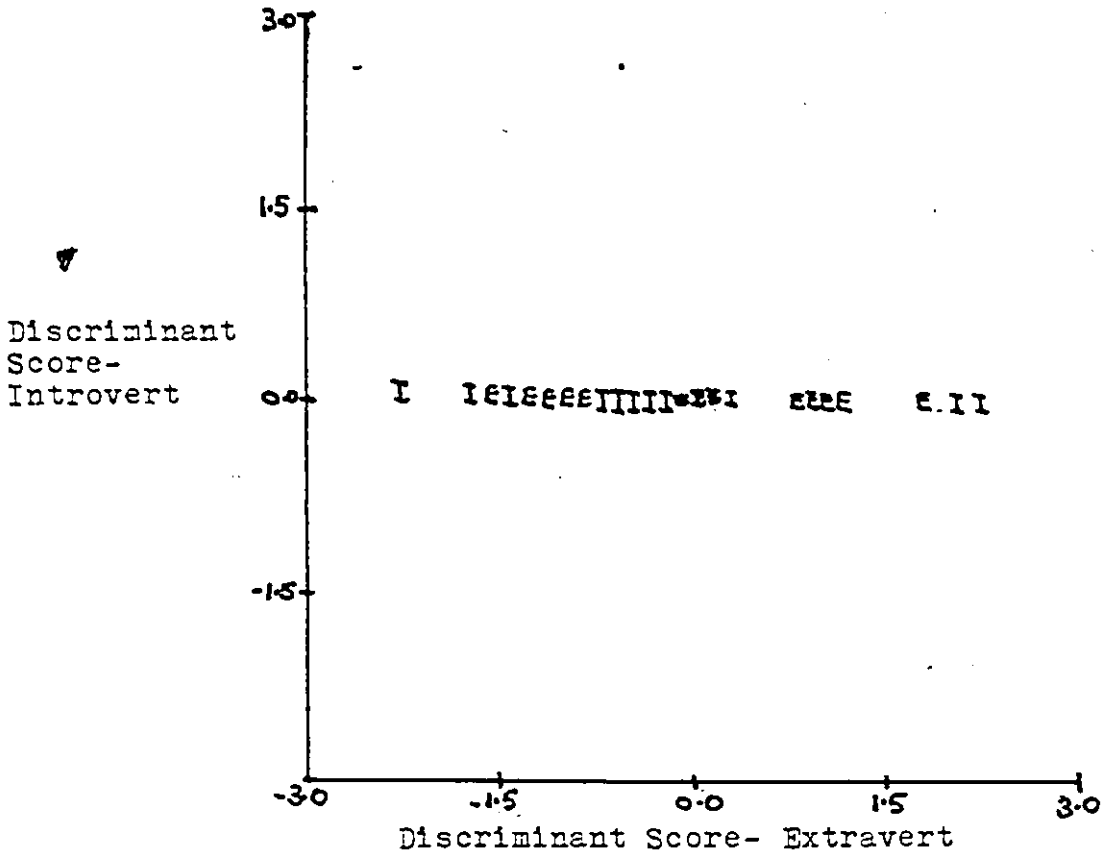
Figure 6

Plot of Discriminant Score Extravert

vs.

Discriminant Score Introvert

for Direct Method with Pupillary Variables



I- Introvert
E- Extravert
*- Group Centroid

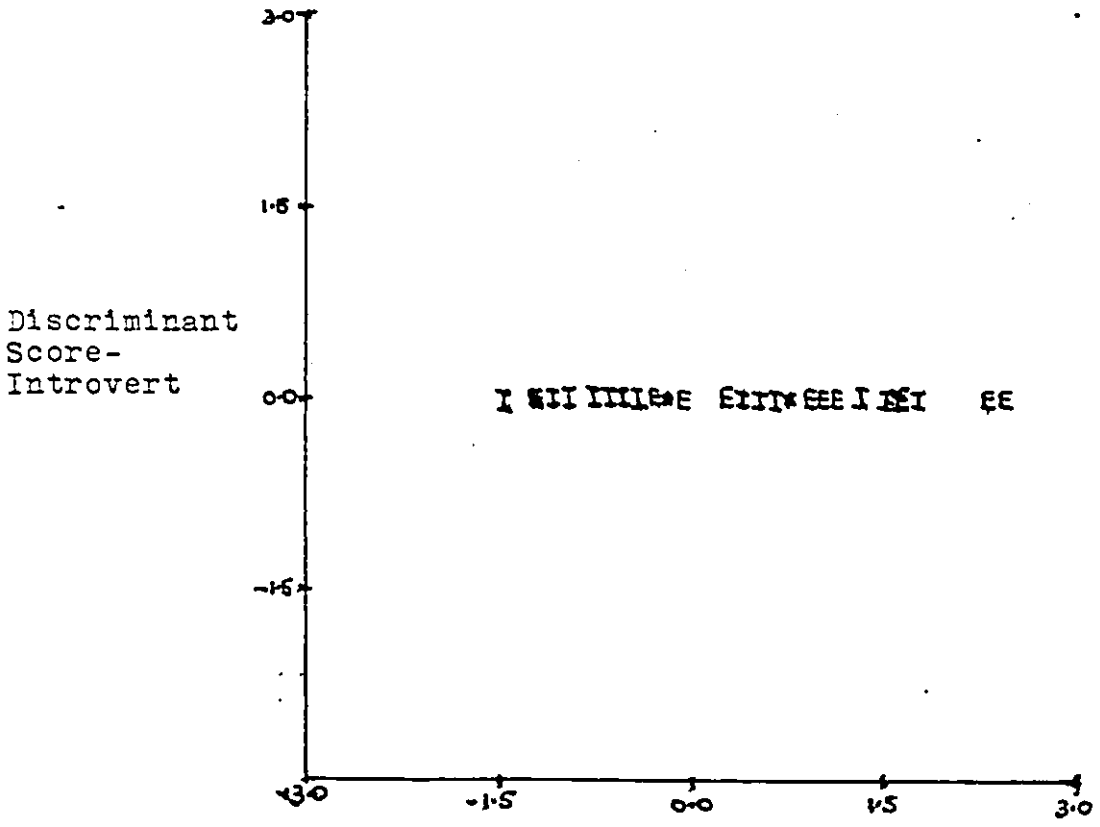
Figure 7

Plot of Discriminant Score Extravert

vs.

Discriminant Score Introvert

for Stepwise Method with Pupillary Variables



I- Introvert
E- Extravert
*- Group Centroid

introverts and extraverts. This means that the discriminating variables were not very successful in discriminating.

Analysis of the eigenvalues, canonical correlations and Wilks' lambda values attests to the poor discriminating power of the variables used.

Lambda is an inverse measure of the discriminating power in the original variables-- the larger lambda is, the less information is available. Lambda can be transformed into a chi-square statistic for an easy test of statistical significance. In the stepwise method with pupillary data alone, the Wilks' lambda is 1.00 with a chi-square of 0.0 which is significant at 1.00. The high lambda and significance level indicate that there is little discriminating power in using the one discriminating variable in the stepwise method. Although the trend in the direct method using all pupillary variables is more favorable with a Wilks' lambda of 0.5743 and converted chi-square significance level of 0.117. it too is not significant. As a result, there is more discriminating power between the criterion using all of the pupillary variables than in using one; however, neither level is significant.

The eigenvalues and canonical correlations further substantiate this. The eigenvalue is a measure of the relative importance of the function derived and the

canonical correlation is a measure of the ability of the function to define the group. The canonical correlation squared is the proportion of variance in the discriminant function explained by the groups. The results of the stepwise method with pupillary data reveal that the discriminant function derived has little importance since its eigenvalue is equivalent to 0.000 and the function has a very low correlation with the groups since the canonical correlation is 0.01. On the other hand, the discriminant function derived using the direct method with pupillary variables exclusively, is relatively important because it has a fairly high eigenvalue (0.741) and the function also has a moderate correlation with the groups since its canonical correlation is 0.652.

In summary, using all pupillary variables in the direct analysis resulted in a more powerful discriminant between introverts and extraverts than using the one variable; however, in the present study, neither method provided significant results. Apparently, the variables did not provide enough discriminating power to result in a significant discriminant function. This may have been due to the small sample of subjects or it could be a consequence of the variables themselves. Further experimentation is required with a larger sample of subjects before the pupillometric variables in this study can be rejected as physiological measures of extraversion-

introversion.

Do the PRF scales add anything to the pupillary variables in discriminating between introverts and extraverts? Given the significance of the stepwise procedures with the PRF scales included as compared to the pupillary variables, it is apparent that the PRF scales do increase the significance of the discriminant function. In fact, the PRF scales alone provided significant discrimination in this study whereas the pupil data did not prove significant.

Interestingly, the pupillary data did improve discrimination between extraverts and introverts. This is borne out by comparing the prediction accuracy, eigenvalue, canonical correlation, Wilks' lambda and centroid difference of the discriminant function yielded using both pupillary and PRF variables with the discriminant function resulting from the PRF variables alone. Since the significance level with the pupillary variables included is higher, it appears that the pupillary data does bear some relation to extraversion-introversion; however, this is not a significant relationship. Comparing the range of possible scores on the PRF and MPI with the pupillary range may be one reason for this lack of significance. The anatomical restrictions of the pupil size combined with precision of the measuring devices used may not yield variation

which is comparable to the variations of the PRF and MPI scales.

CHAPTER 5

SUMMARY AND CONCLUSIONS

The first hypothesis asked if the extraverts and introverts differed with respect to their responsivity to ambiguous and non-ambiguous items. Using actual pupil size as the data for the analysis, there was no significant difference between extraverts and introverts for the two types of items.

The second hypothesis questioned whether pupillary measures or pupillary measures alongwith PRF scores would significantly discriminate extraverts and introverts. The data indicates that there is a positive trend towards discrimination between extraverts and introverts using pupillary measures alone; however, this trend was not significant. The results using pupillary data alongwith PRF scales was significant; however, the only pupillary variables resulting were the response latency for ambiguous and non-ambiguous items. Consequently, the physiological measures alone did not significantly discriminate between extraverts and introverts as measured by the Maudsley Personality Inventory. The pupillary data combined with the PRF scores, however, yielded a significant discrimination as did the PRF scales alone.

APPENDIX A

Simplified Pupillometric Apparatus With Optic Fibre Light Indexing System

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INTRODUCTION

There are many types of pupillometric recorders now appearing on the market. This particular apparatus was designed with two major purposes in mind: (1) that the apparatus be adaptable as possible for various types of psychological research; (2) that cost should be held to a minimum. The basis of this apparatus is the filming system which requires the film to be processed and analyzed. Present techniques are being developed to facilitate this aspect of the work.

The present recording technique owes its existence to many individuals. R. Daly devised the general design and specifications. Mr. Walter Schredl machined and constructed the camera drive mechanism and Mr. Somes adapted the fibre optic system to the existing design.

The operational aspects were put to a rigorous test by the following researchers: James Sweeney, Alan Anderson, Maureen Joyce and Stanley Kuc. Their critical comments have been both encouraging and helpful.

Schematic Symbology

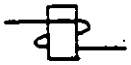
117 V. A. C. Wall Plug

Fuse

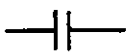
Toggle Switch

Incandescent Lamp

Infra-Red Lamp



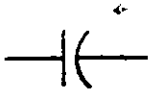
Relay Coil



Normally Open Relay Contacts

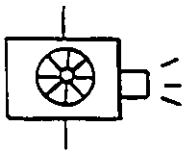
Normally Closed Relay Contacts

Micro Switch

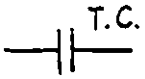


Capacitor

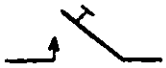
Camera Drive Motor



Projector



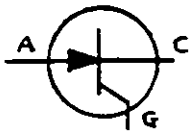
Timer Contacts



Telegraph Key

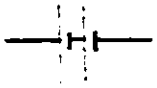
Resistor

Microphone

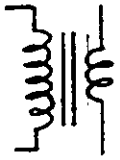


Silicon Controlled Rectifier

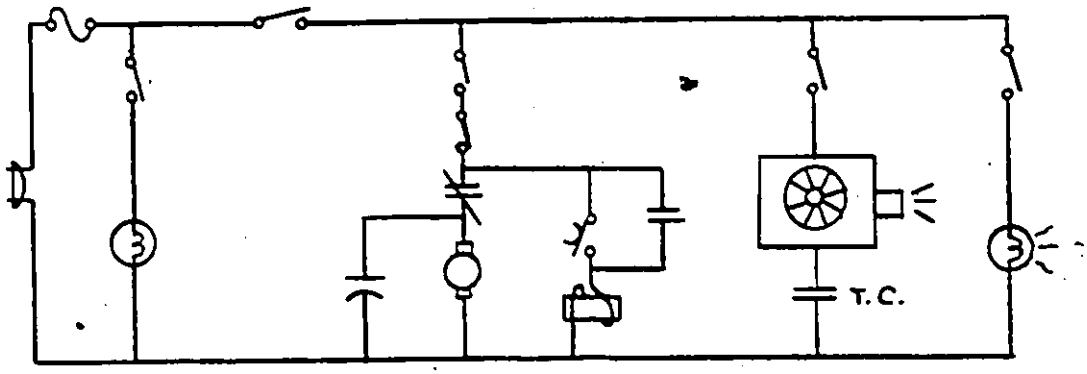
Photocell



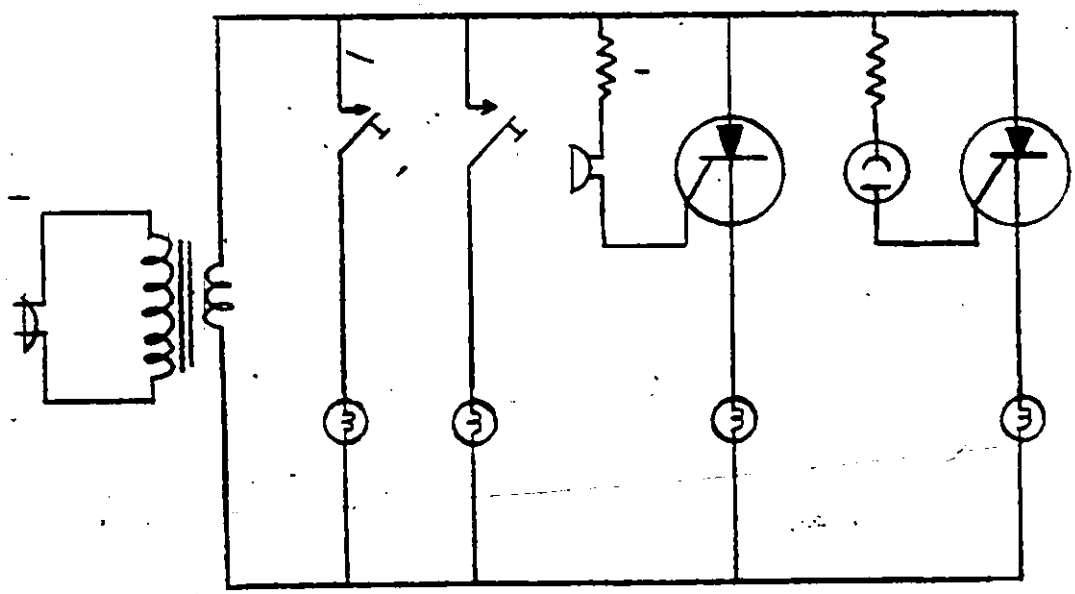
Dry Cell



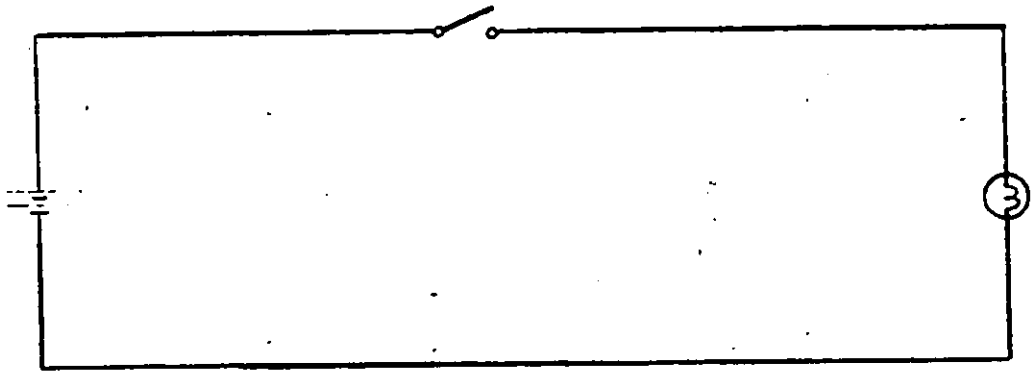
6.3 V. Transformer



Pupillometric Apparatus Circuitry



Indexing Light Control Circuitry



Frame Counter Illuminating Circuitry

Pupillometric Apparatus

Electrical Operation

Before trying to grasp the electrical operation of the three circuits shown, the reader should become familiar with the schematic symbols and their "electrical location" within each circuit. Also, the reader is urged to examine all of the drawings to establish the physical location of the equipment.

Pupillometric Apparatus Circuitry

The physical location of the focus light, projector, infra-red light and toggle switches is shown in the close-up and overhead views of the pupillometric apparatus. The two Hunter electronic timers, which are used as a timing control for the projector are not shown in the drawings but, physically they are situated on the lower shelf of the table which holds the projector. For simplicity, the timers are represented in the circuit diagram as a set of normally open, timed closed contacts. They are connected in the "repetative operation" mode, with a pair of wires attached to the remote control socket of the projector. The camera drive motor, capacitor, micro switch and relay are located within the camera box.

Power for the operation of the circuit is 117 V., A.C. as provided from the standard wall receptacle. The fuse provides electrical burnout protection for the equipment in the event of defective operation.

The toggle switch located in line with the incandescent focus light permits the operation of the focus light independently of the camera drive motor. This prevents accidental exposure of the film during the focussing procedure. The main toggle switch, connected in series with the power source, controls the operation of the camera drive motor, slide projector and infra-red light. Each of these can also be operated remotely by means of toggle switches.

The micro switch, in conjunction with the relay, acts as an electro-mechanical means of stopping the camera drive motor in the event that the film jams or bunches in the camera. The relay can best be described as a magnetic switch controlling one set of normally open and one set of normally closed contacts. With no power supplied to the relay, it is considered to be "at rest" and the contacts are in their normal position as shown in the diagram.

Assuming that the camera drive motor is operating by virtue of the closure of the toggle switches and the normally closed relay contacts, if the film jams or bunches in the camera, the micro switch is actuated by means of the camera drive mechanism. This causes the normally open contacts of the micro switch to close which results in power to be applied to the relay coil. Thus, the normally closed contacts of the relay are opened, thereby disconnecting power from the camera drive motor to prevent damage to the film and camera mechanism. Even though the micro switch contacts may become open the relay will be locked in by means of the closure of the normally open relay contacts. The experimenter then throws the main toggle switch open to disconnect all power to the camera drive motor, the relay, the projector, and the infra-red light. After the jamming problem has been rectified, the

circuit will once again operate as previously described.

Indexing Light Control Circuitry

The location of the telegraph keys, microphone and photocell are clearly shown in the drawing of the pupillometric apparatus. The amplifier, which is not shown in either the circuit diagram nor the apparatus drawings, is located on a shelf underneath the table which supports the apparatus. The microphone is actually connected to the input of the amplifier with the amplifier output connected to the gate of the silicon controlled rectifier. The power cord, transformer, #47 incandescent indexing lamps, resistors, and silicon controlled rectifiers are mounted on or within the indexing light control box. As shown in the apparatus drawings, the fibre optic light guides are mounted in the clear plastic eye piece. The other end of the light guides is mounted in the light indexing control box. Each of the indexing lights is fitted with an opaque shroud, into which the fibre optic light guides are fitted.

The sole purpose of the light indexing system is to provide a means of registering events on the film the instant that they occur, without cueing the subject as to what's going on. The events recorded are: when the stimulus is presented by means of the projector; when the subject responds verbally, when the subject responds manually, and also to provide a means whereby the experimenter could index the film if such a need arose. Electrically, the first two features use the silicon controlled rectifier whereas the last two features use a mechanical key. The silicon controlled rectifier can best be described as a current controlled switch, similar to a relay with one set of normally open

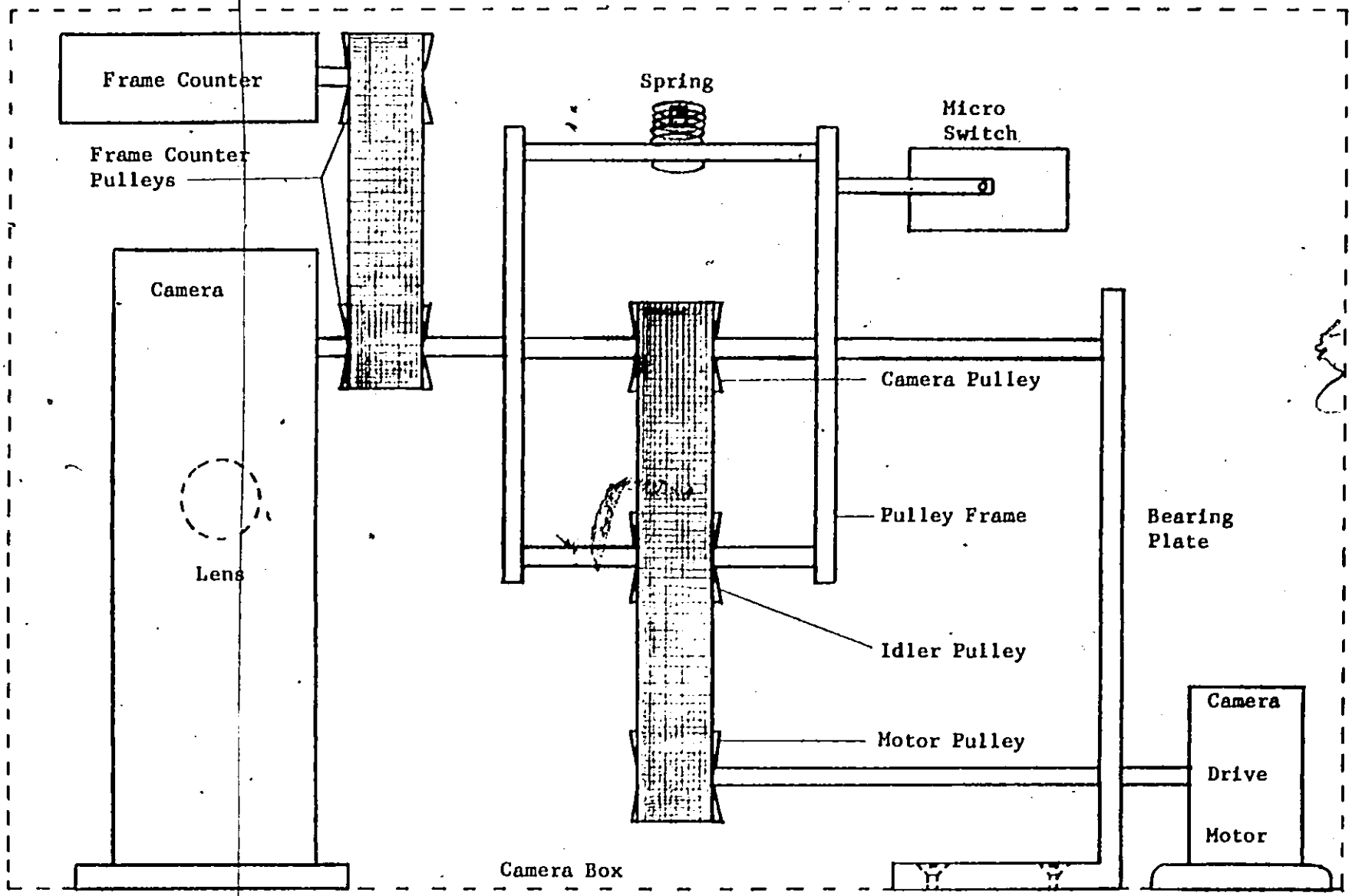
contacts except that it is a semiconductor device. With no current supplied to the gate element, there is effectively an open circuit from the anode to the cathode. However, with gate current supplied from the control source, the silicon controlled rectifier will conduct current thus providing power to the indexing light. Hence, when the projector is operated by means of the timers, the photocell is activated which provides current to the gate of the silicon controlled rectifier. In turn, the silicon controlled rectifier conducts current to the indexing light. The light, which is transmitted through the fibre optic light guide, registers precisely when the stimulus is presented. Similarly, when the subject responds verbally, the microphone, by means of the amplifier and silicon controlled rectifier, registers precisely when the verbal response is made. The subject's response key and the experimenter's indexing key each, when operated, provide power directly to the indexing light.

It is important to note that the fibre optic light guides are mounted in the clear plastic eye piece in such a way that the subject cannot see them when they are illuminated. The end result of the indexing system is that the experimenter has a precise record as to when each event took place. He can tell what event took place by the position of the illuminated light guide in relation to the subject's eye.

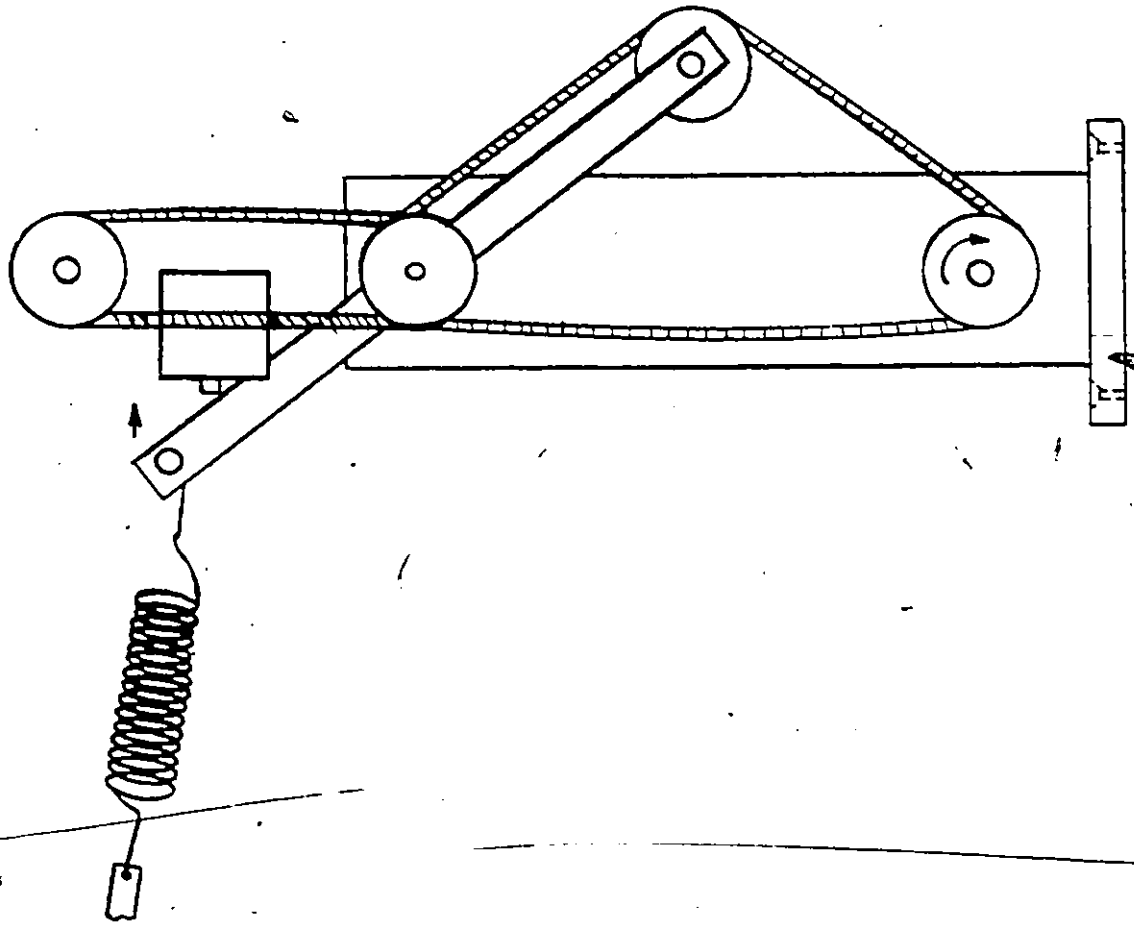
Frame Counter Illuminating Circuitry

Power for this circuit is provided from the 6 V. dry cell, as shown in the schematic diagram. The light, which is mounted near the face of the frame counter, is controlled by a toggle switch located on the camera box. The light serves to illuminate the frame counter so that it

can be viewed in the mirror, by way of the prism, under the darkened conditions within the camera box.



Camera Drive Mechanism - Side View



Camera Drive Mechanism - Front View

Camera Drive Mechanism

To prevent belt slippage and thus insure accuracy, positive drive belts and pulleys are used in the camera drive mechanism. The three purposes of the system are: a drive for the camera, a synchronized drive for the frame counter, and, as mentioned previously, an overload system to disconnect power to the camera drive motor in the event that the film jams or bunches. The spring serves as a belt tightener and it also keeps the pulley frame in a stable position under normal operation thus preventing accidental tripping of the micro switch.

The camera drive and frame counter drive features are clearly shown in the side view of the camera drive mechanism. It is simply a matter of the motor torque being transferred through the belts and pulleys to the camera and frame counter. To understand the operation of the overload disconnect system, the reader should refer to the front view of the camera drive mechanism. When the film jams or bunches in the camera, the camera drive shaft and camera pulley tend to stall momentarily. Since the motor is still revolving at rated speed, it exerts a downward force on the idler pulley which is free to revolve. Consequently, the pulley frame pivots around the camera drive shaft and, when it exerts sufficient force to overcome the tension of the spring, the micro switch is actuated. The micro switch then electrically shuts off the camera drive motor to prevent damage as previously described.

Equipment and Parts List

Item	Manufacturer	Model Number	Specifications
Projector	Kodak	Ektagraphic Model "E"	Kodak 5" Ektanar Lens - f: 3.5
Amplifier	Bogen-Presto	CHA-10	10 Watt
Electronic Timers	Hunter	100 C and 111 C	
Camera	Bolex	H-16 Reflex	16 mm
Camera Drive Motor	Bodine	8070-E553 Type KYC-22 RC	115 V., 60 CYCL. 1 Phase, 7.5 Watt 21 IN. OZ. Torque Continuous Duty
Frame Counter	Veedor-Root	A-110145-EE	5 Digit, Mechanical
Focus Light	G.E.		125 V., 25 W. Incandescent
Infra-Red Light	Monolux		110 V., 20W.
Infra-Red Filter	Kodak	Wratten 87	
Microphone	Shure	540 S. Series II	
Frame-Counter Lamp	G.E.	#47 Pilot	6.3 V.
Indexing Lamps	G.E.	#47 Pilot	6.3 V.
Telegraph Key	Armaco	Tel-K	Adjustable
Photocell-Ft Candle Meter	Gossen	7.67-516	
Belts	Maurey	110XL037	Positive Drive
Pulleys	Maurey	12XL and 15 XL	Positive Drive
Plastic Fibre Optic Light Guides	Du Pont Dist. - Amer. Science Center, 1500 N. W. Hwy., Chicago, Ill.	2507	0.130" Dia., 64 Fibres 3/4" Min. Radius
Microfilm Reader	Dagmar	Model "A"	16 & 35 mm

Item	Manufacturer	Model Number	Specifications
Transformer	Hammond	166-L	115 V. Primary 6.3 V-2A. Secondary
Dry Cell	Burgess	F4M Lantern	6 Volt
Micro Switch	Honey Well	BZ-2RLL	15 A., 125 V-AC., S.P.D.T.
Toggle Switches	Cutler-Hammer	7321-K3	16 A., 125 V., S.P.S.T.
Relay	Potter Brumfield	KRP-11AG	115-V-60 Cycl D.P.D.T. 10 Amps
Silicon Controlled Rectifier	G.E.	GEX1	15 to 25 M.A. Gate Current
Capacitor	Aero Vax	P138 F16	0.85 mfd 220 V-AC
Resistors	Ohmite	"Little Devils"	½ Watt 100 Ohm 10%
Chin Rest	Bausch & Lomb		

APPENDIX B

INSTRUCTIONS: Please answer each question by putting a circle round the "Yes or the "No" following the question; if you simply cannot make up your mind, encircle the "?". Work quickly and do not ponder too long about the exact shade of meaning of each question. There are no right or wrong answers, and no trick questions.

Remember to answer each question.

1. Are you inclined to limit your acquaintances to a select few? ..... Yes ? No
2. Do you prefer action to planning for action? ..... Yes ? No
3. Do you nearly always have a "ready answer" for remarks directed ..... Yes ? No at you?
4. Are your daydreams frequently about things that can never come ..... Yes ? No true?
5. As a child, did you always do as you were told, immediately and ..... Yes ? No without grumbling?
6. Are you inclined to be quick and sure in your actions? ..... Yes ? No
7. Do you have difficulty in making new friends? ..... Yes ? No
8. Do you sometimes put off until tomorrow what you ought to do today? ..... Yes ? No
9. Are you inclined to take your work casually, that is, as a matter of course? Yes ? No
10. Do you often feel disgruntled? ..... Yes ? No
11. Are you inclined to ponder over your past? ..... Yes ? No
12. If you say you will do something do you always keep your promise no matter.. Yes ? No how inconvenient it might be to do so?
13. Do you like to mix socially with people? ..... Yes ? No
14. Are you inclined to be shy in the presence of the opposite sex? ..... Yes ? No
15. Do you sometimes get cross? ..... Yes ? No
16. Do you often experience periods of loneliness? ..... Yes ? No
17. Are you touchy on various subjects? ..... Yes ? No
18. Do you often find that you have made up your mind too late? ..... Yes ? No
19. Are you completely free from prejudices of any kind? ..... Yes ? No
20. Are you inclined to be overconscientious? ..... Yes ? No
21. Do you often "have the time of your life" at social affairs? ..... Yes ? No
22. Do you ever change from happiness to sadness, or vice versa, without good... Yes ? No reason?
23. Do you like to play pranks upon others? ..... Yes ? No
24. Do you sometimes laugh at a dirty joke? ..... Yes ? No
25. Does your mind often wander while you are trying to concentrate? ..... Yes ? No
26. Would you rate yourself as a tense or "high-strung" individual? ..... Yes ? No

Page 2.

27. After a critical moment is over, do you usually think of something you should have done but failed to do? .....Yes ? No
28. Would you much rather win, than lose, a game? .....Yes ? No
29. Do you find it easy, as a rule, to make new acquaintances? .....Yes ? No
30. Do you ever have a queer feeling that you are not your old self? ..... Yes ? No
31. Do you ever take your work as if it were a matter of life or death?..... Yes ? No
32. Are you frequently "lost in thought" even when supposed to be taking part in a conversation? ..... Yes ? No
33. Do you always feel genuinely pleased when a bitter enemy achieves a merited success? Yes ? No
34. Do you derive more real satisfaction from social activities than from anything else? ..... Yes ? No
35. Do ideas run through your head so that you cannot sleep? ..... Yes ? No
36. Do you sometimes boast a little? ..... Yes ? No
37. Can you usually let yourself go and have an hilariously good time at a gay party? .... Yes ? No
38. Do you like to indulge in a reverie (daydreaming)? ..... Yes ? No
39. Have you often felt listless and tired for no good reason? ..... Yes ? No
40. Are all your habits good and desirable ones? ..... Yes ? No
41. Are you inclined to keep quiet when out in a social group? ..... Yes ? No
42. Are you sometimes bubbling over with energy and sometimes very sluggish?.... Yes ? No
43. Do you always answer a personal letter as soon as you can after you have read it? ..... Yes ? No
44. Would you rate yourself as a talkative individual? ..... Yes ? No
45. Do you occasionally have thoughts and ideas that you would not like other people to know about? .. Yes ? No
46. Would you be very unhappy if you were prevented from making numerous social contacts? ..... Yes ? No
47. Are you happiest when you get involved in some project that calls for rapid action? ..Yes ? No
48. Do you spend much time in thinking over good times you have had in the past?.Yes ? No
49. Do you sometimes talk about things you know nothing about? .....Yes ? No
50. Have you ever been bothered by having a useless thought come into your mind repeatedly? .....Yes ? No
51. Do other people regard you as a lively individual?.....Yes ? No
52. Do you sometimes gossip? .....Yes ? No
53. Do you usually keep in fairly uniform spirits? .....Yes ? No

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54. Are your feelings rather easily hurt? .....Yes ? No
55. At times, have you ever told a lie? .....Yes ? No
56. Do you generally prefer to take the lead in group activities? ..... Yes ? No
57. Would you rate yourself as a happy-go-lucky individual?..... Yes ? No
58. Have you money worries at times? ..... Yes ? No
59. Do you have periods of such great restlessness that you cannot sit long ... Yes ? No
in a chair?
60. Are you usually a "good mixer?" ..... Yes ? No
61. Would you rate yourself as a lively individual? ..... Yes ? No
62. Have you ever been late for an appointment or work? ..... Yes ? No
63. Do you ever feel "just miserable" for no good reason at all? ..... Yes ? No
64. Are you often troubled with feelings of guilt?..... Yes ? No
65. Are you inclined to be moody? ..... Yes ? No
66. Do you like to have many social engagements? ..... Yes ? No
67. Once in a while, do you lose your temper and get angry? ..... Yes ? No
68. Do you sometimes feel happy, sometimes depressed, without any apparent..... Yes ? No
reason?
69. Is it difficult to "lose yourself" even at a lively party?..... Yes ? No
70. Are you ordinarily a carefree individual? ..... Yes ? No
71. Do you have frequent ups and downs in mood, either with or without ..... Yes ? No
apparent cause?
72. Would you always declare everything at the Customs, even if you knew that... Yes ? No
you could never be found out?
73. Do you like work that requires considerable attention to details?..... Yes ? No
74. Are there times when you seek to be alone and you cannot bear the company ...Yes ? No
of anyone?
75. Are you inclined to keep in the background on social occasions?.....Yes ? No
76. Have you often lost sleep over your worries? .....Yes ? No
77. Of all the people you know are there some whom you definitely do not like?...Yes ? No
78. Do you usually feel disappointments so keenly that you cannot get them out ..Yes ? No
of your mind?
79. Do you usually take the initiative in making new friends?.....Yes ? No
80. Do you enjoy participating in a showing of "Rah Rah" enthusiasm? .....Yes ? No

Please answer each question by putting a circle around the "yes" or the "no" for each question. If you simply cannot make up your mind encircle the "?".

1. Yes ? No
2. Yes ? No
3. Yes ? No
4. Yes ? No
5. Yes ? No
6. Yes ? No
7. Yes ? No
8. Yes ? No
9. Yes ? No
10. Yes ? No
11. Yes ? No
12. Yes ? No
13. Yes ? No
14. Yes ? No
15. Yes ? No
16. Yes ? No
17. Yes ? No
18. Yes ? No
19. Yes ? No
20. Yes ? No
21. Yes ? No
22. Yes ? No
23. Yes ? No
24. Yes ? No
25. Yes ? No
26. Yes ? No
27. Yes ? No
28. Yes ? No
29. Yes ? No
30. Yes ? No
31. Yes ? No
32. Yes ? No
33. Yes ? No
34. Yes ? No
35. Yes ? No
36. Yes ? No
37. Yes ? No
38. Yes ? No
39. Yes ? No
40. Yes ? No
41. Yes ? No
42. Yes ? No
43. Yes ? No
44. Yes ? No
45. Yes ? No
46. Yes ? No
47. Yes ? No
48. Yes ? No
49. Yes ? No
50. Yes ? No
51. Yes ? No
52. Yes ? No
53. Yes ? No
54. Yes ? No
55. Yes ? No
56. Yes ? No
57. Yes ? No
58. Yes ? No
59. Yes ? No
60. Yes ? No
61. Yes ? No
62. Yes ? No
63. Yes ? No
64. Yes ? No
65. Yes ? No
66. Yes ? No
67. Yes ? No
68. Yes ? No
69. Yes ? No
70. Yes ? No
71. Yes ? No
72. Yes ? No
73. Yes ? No
74. Yes ? No
75. Yes ? No
76. Yes ? No
77. Yes ? No
78. Yes ? No
79. Yes ? No
80. Yes ? No

PROJECT QUESTIONNAIRE

DATE _____ SUBJECT # _____

MAX. DILATION _____ AVERAGE _____ MAX. CONSTRICTION _____

Name _____ Eye Color _____

Age _____ Education _____

Sex _____ Local Address _____

Phone _____

Here is a list of the items to which you responded during the experiment. Is the meaning of each item clear to you? Rate each item as to its clarity according to the seven point scale below. Please place the number of the category that you feel best denotes the clarity of the meaning of the item, in the space provided beside each item.

1. extremely clear 2. very clear 3. moderately clear 4. neither clear nor unclear 5. moderately unclear 6. very unclear 7. extremely unclear.

Pecular odors come to me at times _____
I think I would like the work of a librarian _____
I like repairing a doorlatch _____
I am an important person _____
I am easily downed in an argument _____
I believe in a life hereafter _____
Many of my dreams are about sex matters _____
I like mechanics magazines _____
I am not afraid of fire _____
I would like to be an autoracer _____
I get all the sympathy I should _____
I am never happier than when alone _____
I have no enemies who really wish to harm me _____
Some of my family have quick tempers _____
I believe I am no more nervous than most others _____
I have stong political opinions _____
I seldom worry about my health _____
I can stand as much pain as others _____
I feel hungry almost all the time _____
I almost never dream _____
I gossip a little at times _____
My neck spots with red often _____
I have a daydream life about which I do not tell other people _____
I believe that women ought to have as much sexual freedom as men _____

APPENDIX C

APPENDIX C

Experimental Stimulus Items

Exp. Item No. 1	MMPI No.	Item	No. of Letter	Amdex 0-200	Desirability
PI	550	I like repairing a door latch.	24	056	541
PE	424	I feel hungry almost all the time.	27	050	422
B1	036	I seldom worry about my health.	25	057	529
B2	320	I almost never dream.	17	050	471
1	511	I have a daydream life about which I do not tell other people.	38	076	364
2	334	Peculiar odors come to me at times.	28	078	367
3	367	I am not afraid of fire.	15	087	594
4	306	I get all the sympathy I should.	25	093	510
5	286	I am never happier than when alone.	28	109	353
6	347	I have no enemies who really wish to harm me.	35	082	647
7	242	I believe I am no more nervous than most others.	38	081	581
8	073	I am an important person.	20	089	419
9	320	Many of my dreams are about sex matters.	32	076	465

Exp. Item No. 1	MMPI No.	Item	No. of Letter	Amdex 0-200	Desir-ability
10	532	I can stand as much pain as others.	27	088	585
11	225	I gossip a little at times.	21	035	454
12	246	My neck spots with red often.	22	000	354
13	101	I believe women ought to have as much sexual freedom as men.	48	021	485
14	001	I like mechanics magazines.	23	023	548
15	434	I would like to be an autoracer.	25	025	524
16	516	Some of my family have quick tempers.	30	021	452
17	432	I have strong political opinions.	28	028	582
18	004	I think I would like the work of a librarian.	35	028	582
19	115	I believe in a life hereafter.	24	033	670
20	082	I am easily downed in an argument.	27	033	353
		MEANS	28.3	024.7	488.4

APPENDIX D

Discriminant Function Coefficients

for the Stepwise Method

with Pupillary and PRF Variables

Variable	Standardized Coefficient	Unstandardized Coefficient
LATAMB	-0.56024	-0.03486
LATNAMB	0.55652	0.03644
AC	-0.23700	-0.06039
AF	-0.42251	-0.10866
AU	0.19289	0.06431
EX	-0.31431	-0.07333
IM	-0.46832	-0.13034
CONSTANT		3.91295

Discriminant Function Coefficients

for the Stepwise Method

with PRF Variables

Variable	Standardized Coefficient	Unstandardized Coefficient
AF	0.28682	0.07376
AU	-0.19751	-0.06585
EX	0.55880	0.13037
IM	0.36748	0.10228
NU	-0.27885	-0.07181
OX	0.32150	0.06655
CONSTANT		-2.57771

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